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Devoted to Commercial and Naval Motor Craft

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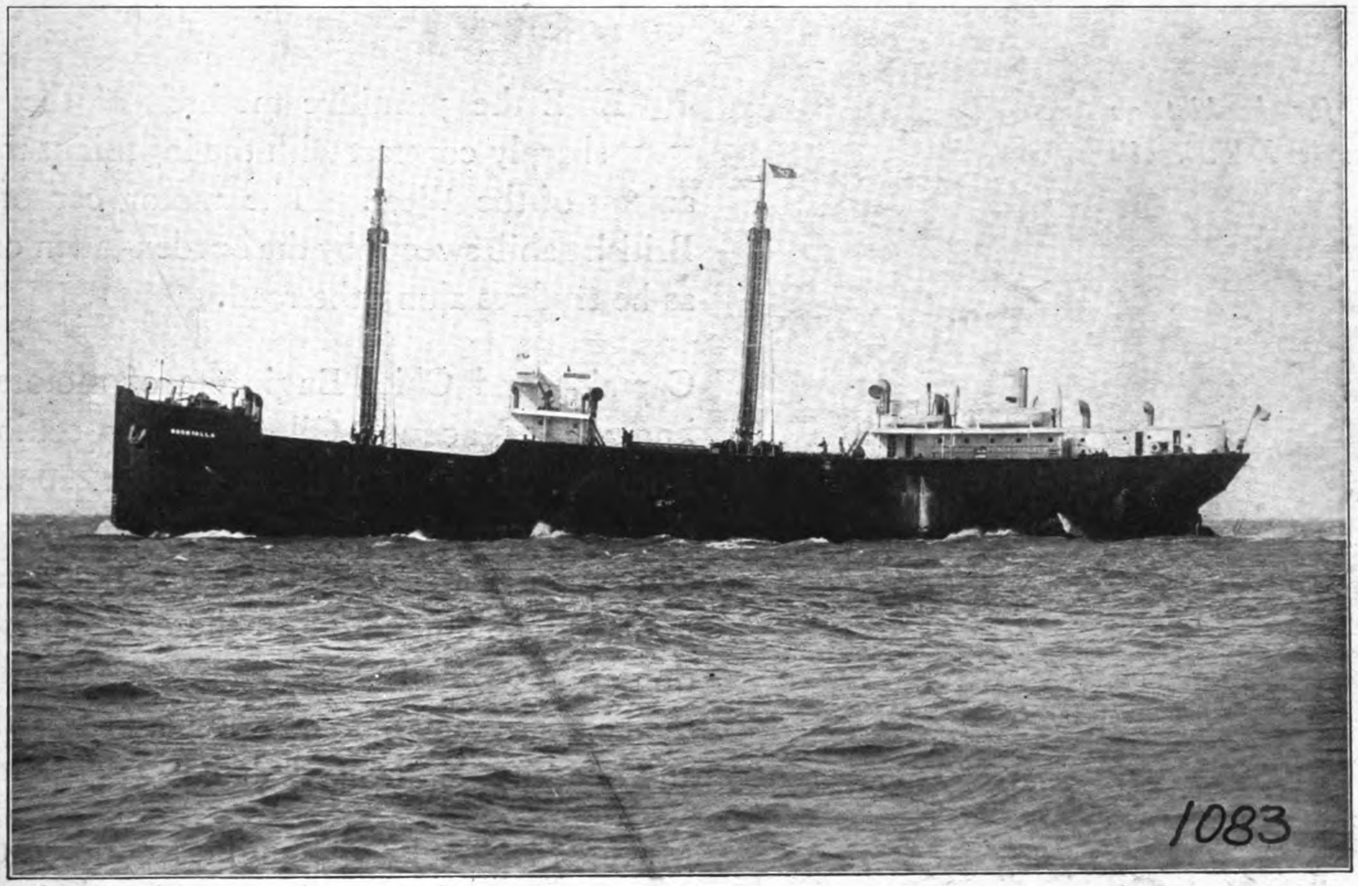

MOTORSHIP

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Australia—Gordon & Gotch, Sydney & Melbourne.

The oil-engined motorship has arrived! It is such a pronounced economy that it was bound to come. Nothing could stop it! And all obstacles have been removed as fast as they arose. The law of progress has seen to that. Very strong prejudices stood in the way of steam. But, one after another they were swept aside and steam reigned triumphant for a century. Steam now has had its day! Its zenith has passed, and gradually but surely it is being superseded by the economical internal-combustion power. Steamships have become decadent. America, the most important oil-producing country, is to be the greatest motorship-owning nation. Let us all co-operate and assist to make that day soon.

July, 1920 Vol. 5 No. 7

EDITORIAL

One-Hundred-and-Twenty-five-Million Dollars for American Motorships

Passing of Jones-Greene Bill by Congress Provides Funds to Aid Ship Owners Construct Most Economical Type of Ship

UNDER the new Merchant-Marine Act American shipowners are entitled to the loan of a total of $125,000,000.00 during the next five years for the purpose of constructing new motorships. The Jones-Greene Bill has been signed by the President of the United States and has become law.

On the whole this Act—while not perfect—is one of the most carefully worked-out and important pieces of legislation ever drawn-up and made law, and has the approval of the majority of the people of this country. Senator Wesley L. Jones and members of the Senate and House Committees can be congratulated upon what has meant to them months of exhaustive investigation and labor.

AN ACT TO PROVIDE FOR THE PROMOTION AND MAINTENANCE OF THE AMERICAN MERCHANT MARINE

(Section Eleven)

Sec. 11. That during a period of five years from the enactment of this Act the board may ANNUALLY set aside out of the REVENUES FROM SALES AND OPERATIONS A SUM NOT EXCEEDING $25,000,000, to be known as its construction loan fund, to be used in the construction, or IN AID OF THE CONSTRUCTION, OF VESSELS OF THE BEST AND MOST EFFICIENT TYPE for the establishment and maintenance of service on steamship lines deemed desirable and necessary by the board, AND SUCH VESSELS SHALL BE EQUIPPED WITH THE MOST MODERN, THE MOST EFFICIENT, AND THE MOST ECONOMICAL MACHINERY AND COMMERCIAL APPLIANCES. The board shall use such fund to the extent required upon such terms as the board may prescribe to aid persons, citizens of the United States, in the construction by them in private shipyards in the United States of the foregoing class of vessels. No aid shall be for a greater sum than two-thirds of the cost of the vessel or vessels to be constructed, and the board shall require such security, including a first lien upon the entire interest in the vessel or vessels so constructed as it shall deem necessary to insure the repayment of such sum with interest thereon and the maintenance of the service for which such vessel or vessels are built.

It is hardly necessary to mention that "MOTORSHIP" has worked incessantly during the last four years to have Congress order the construction of motorships. The recommendations which we made to the U. S. Senate's Committee on Commerce no doubt weighed heavily with the decision of the Senators. They were published in our March, 1920, issue. When the Jones-Greene Bill was returned to the House by the Senate it contained a clause providing a fund of $50,000,000.00 per annum for five years for new Federal motorship construction, and to assist private shipowners to construct motorships. At the last hour this fund was reduced by the House to a revolving fund of $25,000,000.00 per annum for that period to aid private ship-

owners in the construction of motorships up to two-thirds of the value of the ships.

While we prefer to see private shipping concerns order the construction of motorships rather than the Shipping Board, we regret that the fund for—and authorization of—Federal motorship construction has been cut-out of the Act, as shipowners would have operated the proposed Shipping Board economical fleet-balancing Diesel-craft side by side with their existing oil and coal wasting steam-driven ships, and so would have been afforded splendid first-hand opportunities of convincing themselves of the extraordinarily huge financial savings to be made with motorships, and undoubtably would have availed themselves of the new fund to the fullest extent.

As may be expected the Act does not definitely define the new vessels as "Diesel ships," as we understand such a term would not be ethical in legislation, but nevertheless it outlines this type of vessel so clearly that the matter is beyond dispute. We give Section Eleven in the insert on the previous page. Part of it states—

> "and such vessels shall be equipped with the *most modern, the most efficient and the most economical machinery* and commercial appliances. The Board shall use such fund to aid persons, citizens of the U. S. A., in the construction of *the foregoing class of vessels.*"

Senator Wesley L. Jones, of Washington, who sponsored the new Merchant Shipping Act through Congress

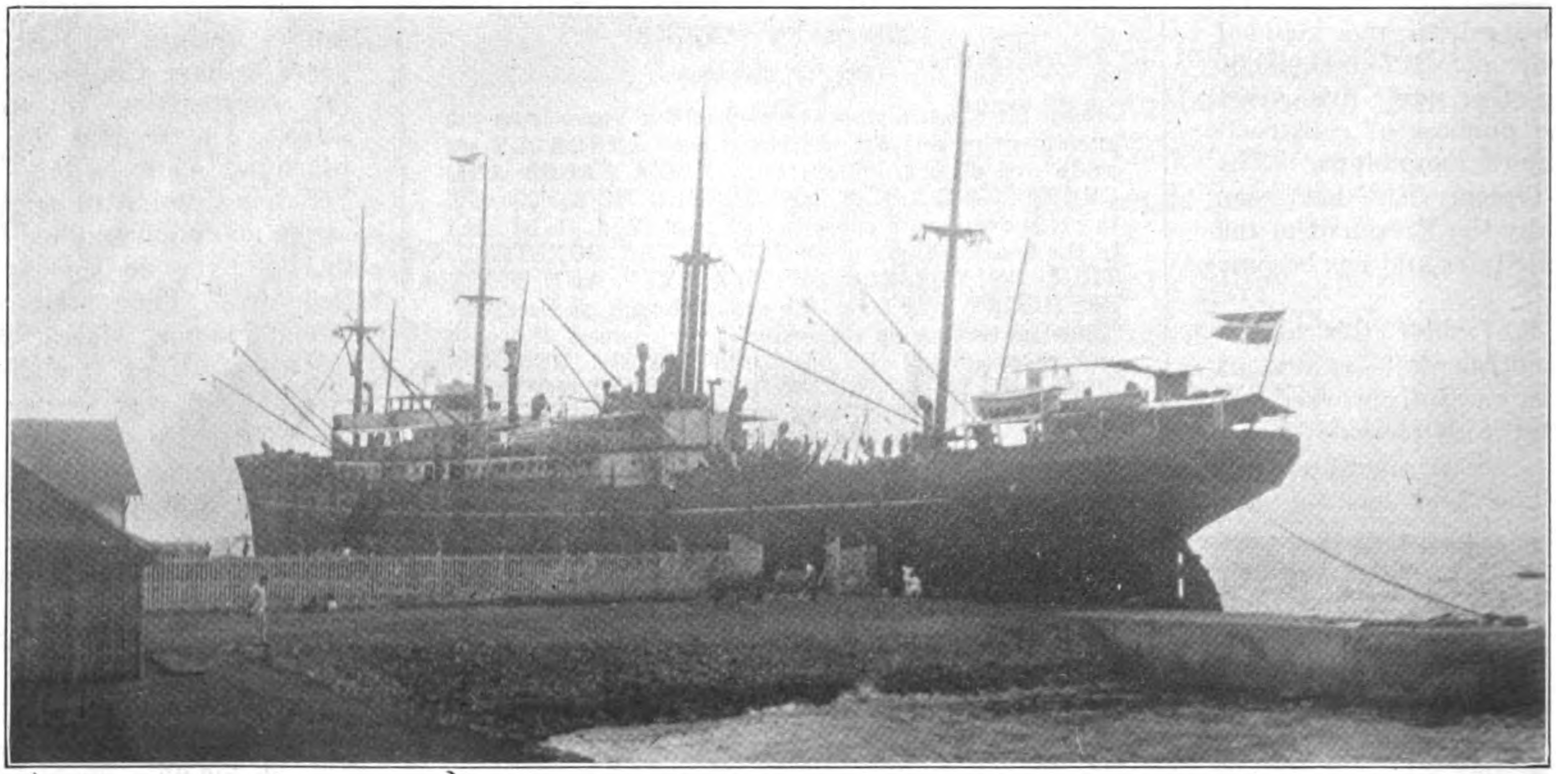
We draw the attention of the Shipping Board to this clause which in our opinion and in the opinion of many well known people makes it illegal to use the funds in question to construct uneconomical *steam*-driven vessels, that waste the nation's oil and coal. The only exception, of course, is in the case of large and fast passenger liners, for which we do not think the fund is intended, motorships being in the Senators' minds.

No man can deny that to-day the Diesel-type internal-combustion heavy-oil engine is the *most modern, the most efficient, and the most economical* marine propelling-machinery for cargo and cargo-passenger ships up to 20,000 tons displacement, and steps will be taken to prevent any attempt to use these funds for constructing or installing uneconomical and inefficient and "semi-obsolete" machinery in vessels. The absolute success and economy of existing motorships up to this size indicate to what tonnage such ships can be built.

We take the opportunity to give an extract from an Editorial, published on page 8 of our issue of November, 1918.

> "Due to the inherent economy of the motorship its use enables possible a conservation of the world's limited store of liquid-fuel, and because its combined advantages will encourage a more extensive post-war development of industry and commerce throughout the United States, the motor-shipping subject is one that positively cannot be stopped from forcing its way to the front, and undoubtedly a huge motorship building program will be embarked upon in this country. It only remains a question whether the steps will be taken at once, in six months, or in two years. It is "MOTORSHIP'S" opinion that the change from steamer to motorship construction is much nearer than many of us believe possible, and when it does come it will sweep over the shipyards like a great tidal wave. The handwriting is on the wall and cannot be obliterated. The future business welfare of the nation is at stake."

America's supply of mineral-oil is swiftly dwindling and new motorships will enable a very large quantity to be saved. We once again suggest that the big coal companies turn their attention to the production of fuel-oil from coal. Two-hundred million tons of coal will producer over five-hundred million barrels (500,000,000 bbls.) of excellent tar-oil fuel for Diesel-driven motorships, in addition to 7,500,000 barrels of benzol for automobiles and 3,000,000 tons of sulphate-of-ammonia for fertilizer. This does not affect the production of gas and coke from this coal. On this kind of fuel practically all the German submarines were operated during the war, as will be the new German mercantile marine when completed. The Diesel engine—despite its critics—is certainly a more wonderful machine than some of us realize. Only a few weeks ago, S. M. Darling, fuel-engineer of



The motorship "Panama" of the Danish East Asiatic Line loading copra

the U. S. Bureau of Mines pointed-out that from one ton of lignite 15 gallons of oil and tar, 10,000 cubic feet of gas, 65 gallons of ammoniacal liquor, and 955 lbs. of excellent fuel could be obtained.

Another excellent feature of the new Act is contained in Section 25, which makes legal classification of ships by the American Bureau of Shipping. We append this Section as follows:

"Section 25. That for the classification of vessels owned by the United States, and for such other purposes in connection therewith as are the proper functions of a classification bureau, all departments, boards, bureaus, and commissions of the Government are hereby directed to recognize the American Bureau of Shipping as their agency so long as the American Bureau of Shipping continues to be maintained as an organization which has no capital stock and pays no dividends: Provided, That the Secretary of Commerce and the Chairman of the board shall each appoint one representative who shall represent the Government upon the executive committee of the American Bureau of Shipping, and the Bureau shall agree that these representatives shall be accepted by them as active members of such committee. Such representatives of the Government shall serve without any compensation, except necessary traveling expenses: Provided further, That the official list of merchant vessels published by the Government shall hereafter contain a notation clearly indicating all vessels classed by the American Bureau of Shipping."

The American Bureau of Shipping realizes the importance of the motorship, and immediately following the passing of the Jones-Greene Bill held a meeting of Diesel-engine builders for the purpose of revising the present oil-engine machinery rules and regulations of the Bureau. Twenty representatives of about fifteen American companies attended and a sub-committee was formed to attend to details. Unfortunately several well-known engine-builders were not present, but the meeting was well representative of the American marine oil-engine industry.

THE GREAT AMERICAN SHIPPING COMBINE

Except in certain services, small American *steam*ship-owning companies will stand scant chances of successful operation in world-wide ocean trades with the changing from abnormal conditions to those more ordinary, so the combination of the Harriman and Kerr interests are of vast moment to our new merchant marine. Except in special circumstances, chances of minor shipowners maintaining a reasonably prosperous existence against the powerful competition of other countries remain only in the use of tramp motorships, sneaking cargoes here and there, their economy allowing them to offer more attractive rates than foreign coal and oil-burning steamers. But, of course, this condition may not apply where they will be called upon to compete against well-organized European motorship fleets. The day of making fortunes with anything that floats, no matter how inefficiently operated, has gone, perhaps never to return.

Therefore, the backbone of our mercantile marine must be the big shipping organizations with their associated banks, traders, merchants, insurance concerns and other influencing connections. In consequence thereof, such great and reputable combinations as that recently made should receive the greatest support from the United States, and the general public should be encouraged to invest in their stocks. Their success will eventually reflect upon the entire business of the country.

It is well to dwell for a moment upon the units of this particular shipping combine, the total maritime property of which has a valuation of about one hundred and twenty million dollars apart from the good-will of each company. The following are included:

Steamship Companies

American-Hawaiian Steamship Co.....16 ships—174,330 tons
(Also two 11,200 tons d.w.c. motorships building)
American Ship & Commerce Corp........10 ships—77,605 tons
(Kerr Navigation Co.)
Shawmut Steamship Co.................3 ships—21,000 tons
Coastwise Transportation Co............10 ships—76,300 tons
Livermore, Dearborn & Co..Operating 42 Shipping Board Ships

Shipbuilding Plants

Merchant Shipbuilding Corp....................Chester, Pa.
Merchant Shipbuilding Corp.....................Bristol, Pa.
Wm. Cramp & Sons Ship & Eng. Bldg. Co......Philadelphia, Pa.

Engineering Plants

American Engineering Co...................Philadelphia, Pa.
De La Vergne Machine Co..................New York, N. Y.
Wm. Cramp & Sons Ship & Eng. Bldg. Co......Philadelphia, Pa.

Marine Insurance

Monks, Goodwin & Shaw....................New York, N. Y.

Marine Securities & Bank

W. A. Harriman & Co.......................New York, N. Y.
Chandler & Co.............................New York, N. Y.

Both the American-Hawaiian and the Kerr Navigation Companies have large sums of money available for new construction, and both will use their funds for new motorship construction, although some large steam-driven ocean passenger liners may be built. They also may increase the building power of their present cash-in-hand by applying to the U. S. Shipping Board for part of the $25,000,000.00 now available every year for motorship construction, loans up to two-thirds of the ship's value being obtainable.

We also have an idea that they will be given the operation of the Shipping Board's new 12,000 tons d.w.c. motorship "William Penn" when she is ready towards the end of this year. It is well-known that Cramps, their associated shipyard, has the American license for the Burmeister & Wain Diesel engine, also the De La Vergne Co. are Diesel motor builders, so every indication tends to cause anticipation of a large motorship fleet in the near future, which will augment the two 11,200 tons d.w.c. motorships now on order. It is pleasing that these associated companies are enthusiastic over Diesel engine propulsion. The Kerr company will use the Diesel-electric drive for their ships.

A REMARKABLE ANNOUNCEMENT

Shipowners who are still in the least chary of the reliability of—or the means to successfully build and operate—American Diesel-engined merchant-motorships should carefully read the special announcement of the Worthington Pump Company in the publicity pages in the front section of this issue. This old-established company is too well-known to shipping men to refer to their various engineering accomplishments. Attention is drawn to the fact that, although they have been prominent builders of marine steam-engines and have invested large sums in suitable machinery for their manufacture, they go to the extent of emphasizing their confidence in the motorship and its benefits and urge shipowners to adopt this type of machinery, backing their convictions by investing half a million dollars in the building of a high-powered Diesel-engine to their own order.

WHY THE UNFAIR DISCRIMINATION?

Some time ago the Emergency Fleet Corporation found themselves left with a large number of 1450 I.H.P. sets of steam-machinery originally intended for wooden hulls on the Pacific Coast. They also found themselves with about half the number of twin-screw Diesel sets of about the same power. The corporation has been holding out for about $100.00 or more per horse-power for the Diesel-engines, or about $145,000.00 per twin-screw set. But they have been selling the steam-engines at $25,000.00 each and the water-tube boilers for $8,300.00 to shipowners on the Pacific Coast, or approximately $23.00 per horse-power. This has resulted in most unfair competition to the Diesel-engine manufacturers of the United States, as the extremely low cost of the steam-sets has caused shipowners to place orders for steam-driven vessels instead of ordering economical Diesel-engined motorships. Obviously a considerable amount of business has been lost to the United States Diesel-engine industry through this unfair action of the Corporation.

Progress in Marine Diesel-Engine Building at Krupp's During the War

A Great Number of 1,250 Shaft H.P. Merchant-Ship Four-Cycle Type Diesel-Engines Now Under Construction. Double-Acting, Port-Scavenging, Two-Cycle Sets for Powers Over 4,000 Shaft H.P.—Four-Cycle Sets of 19,000 Shaft H.P in 12 Cylinders Possible With Super-Compression

By OTTO ALT

Chief-Engineer, Oil-Engine Dep't, Krupp's Germania Works, Kiel, Germany

["Motorship" has the greatest writers on marine heavy-oil engine and motorship subjects in the world contributing to its pages, in many cases exclusively. "Motorship" seeks to maintain the most interesting and valuable maritime publication in the world. As in the past, its editorial pages will speak for themselves in the future.—*Editor.*]

THERE is at present an exceedingly great *demand* for stationary and marine Diesel oil-engines in the whole world. It is caused on the one hand by the shortage and the high prices of coal, on the other hand by the general recognition of the unrivaled economy of this system of power.

After the initial development of the Diesel-engine from 1893-97, two problems remained to be solved: first *the burning of cheap fuels,* especially of tar, and secondly the *generation of high power per unit.*

The solution of these two problems in the time from 1908 to the present day initiated the victorious progress of the Diesel-engine for land and marine work. During their indefatigable endeavors Diesel-engine builders more and more came to make use of scientific methods in order to avoid the waste of time and labor.

To attain the above ends Krupp's Germaniawerft at Kiel has done *experimental work,* which gave remarkable results and which will be communicated here together with some important experiences in oil-engine building. As this experimental work has been in close connection with oil engines built by the Germaniawerft, first some of the most noteworthy types of engines will be described with their principal dimensions and their characteristic and prominent features.

Oil-Engine Building

Before and during the war the Germaniawerft has chiefly built submarines and their machinery, and held the first position in Germany. In oil-engine building, therefore, the Diesel-engine for submarine was her chief work.*

In the following some *typical oil-engines for submarines* are described. Fig. 1 is a two-cycle engine giving 1,150 B.H.P. at 400 revolutions. This engine was referred to by Mr. Regenbogen, Director of Germaniawerft, when sketching the evolution of the Diesel-engine at the summer-meeting, 1912, of the Schiffbautechnische Gesellschaft. The cylinder bore is 390 mm. and the stroke 450 mm. While the former engines of the Germaniawerft had the scavenging-pumps at the aft and forward end and the air compressor in the middle of the engine, we see here at the forward end a tandem scavenging-pump and a three-stage air-compressor. The engine is of the *valve scavenging type* with 3 scavenging-valves in the cylinder-head. There have been delivered 26 engines of this type for the German submarines U 66-70, 96-98, 112-114 and for two Austrian submarines.

Fig. 2 represents an engine of the *port-scavenging type,* having the same dimensions and giving 1,100 B.H.P. at the same number of revolutions. Besides the scavenging-ports in the liner, this engine has one scavenging-valve in the cylinder head for charging up the cylinder with air. Of this type 6 engines delivered for the German submarines U 63-65 proved most reliable, and were very much appreciated by the staff of the boats.

Fig. 3 shows a larger engine of the same valve-scavenging type as Fig. 1. Here the scavenging-pumps and the air-compressors are arranged at the forward end and driven by three cranks. Two scavenging-pumps are mounted over the first and third crank, the one being combined with the first stage, and the second with the second stage of the air-compressor; between these the third stage of the air-compressor is mounted over the second crank. The main dimensions are:

Shaft—(Brake) H.P. .... 1,650 H.P.
Revolutions .... 350 per minute
Bore and Stroke .... 450 by 500 mm.

Two of these engines were installed in the German submarine cruiser U 139.

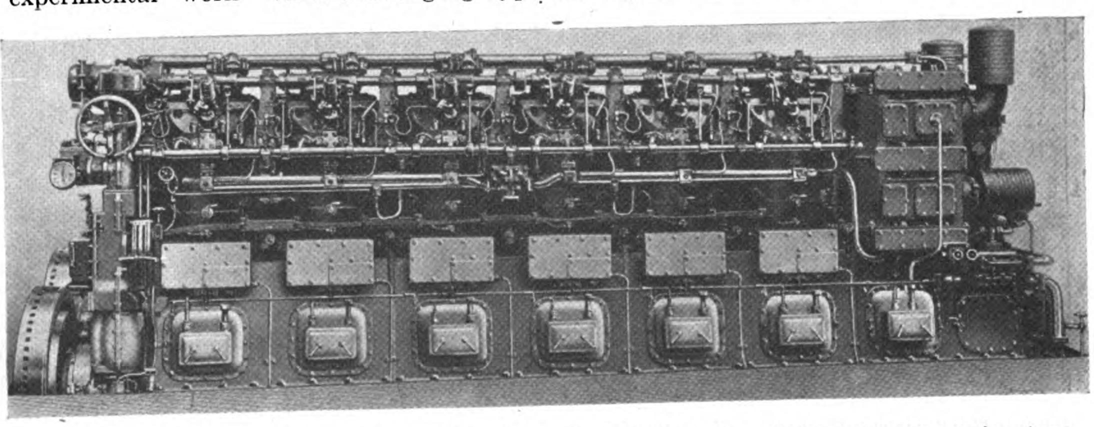


Fig. 1. Krupp, 1150 shaft h. p. two-cycle submarine Diesel engine of the valve-scavenging type

The favorable experiences made with its four-cycle engines were decisive, for the construction of larger four-cycle plants for submarines. These experiences were obtained on four-cycle engines, built to drive dynamos on German battle-ships, and during the war, for propelling the famous cargo submarines "Deutschland" and "Bremen," and six submarine-cruisers of the same dimensions. Fig. 4 represents the new type, having the following dimensions:

Shaft H. P. .... 1,200 (1,700) H.P.
Revolutions .... 430 (370) per minute
Bore and Stroke. 440 (530) by 440 (530) mm.

A 1,700 B.H.P. four-cycle submarine engine of the same type is often mentioned in this article. The dimensions of this engine are given in parentheses.

The evolution of the Diesel oil-engine for *merchant vessels* in Germany was suddenly interrupted by the war. The reasons which led the Germaniawerft to build *four-cycle engines for cargo-ships* after the war, will be explained below. Krupp is building at present a great number of four-cycle engines of the cross-head-type, some of which will soon be finished. The main dimensions are:

Shaft H.P., 1,200 (1,700) H.P.; revolutions, 120 per minute; bore and stroke, 650 by 1,000 mm.

These engines are suitable for single or twin-screw ships of 4,000 to 10,000 tons displacement; they may also be employed for stationary purposes. The Germaniawerft is building these four-cycle engines as 6 and 8 cylinder sets of 750 to 4,000 shaft H.P. *Larger engines are to be built as double-acting two-cycle port scavenging engines.*

For smaller powered marine-engines the firm has developed a new stationary trunk-piston type. The smallest engines of this type are non-reversible with two and four cylinders, and may be delivered with reversing propellers of the well-proved Germania-Werft-type. From 500 to 750 B.H.P. these trunk-piston engines have six cylinders and

*Vide the article of Dr. Ing. Techel, of the Germaniawerft: "Der Bau von Unterseebooten auf der Germaniawerft," "Zeitscrift des Vereins Deutscher Ingenieure," 1919 and 1920. In the issue of 21. February there is a detailed description of all the submarine engines, built by the Germaniawerft.

are directly reversible; an engine of this type is represented by Fig. 6. Moreover, at the Krupp works the well-known A-type engine for stationary plants and the enclosed type for stationary and ship purposes is being built.

The new engines of the Germaniawerft show the marked progress resulting from a nearly 20 years' experience with different types of oil-engines, and from the research work of the firm.

The following discussion of the chief problems will serve to give an idea of the progress made.*

Torsional Vibrations of Shafts

The *torsional vibrations of crankshafts,* resulting from the irregular crank effort and from the rotating masses, had been investigated by several scientific pioneers before the war, but actual practice did not draw the last conclusions from it. Engineers contented in estimating the causes of vibrations and in calculating the critical speeds of different grades and orders. In Germany, the way for *determining critical speeds by calculation* was shown by Professor Gümbel, of the Technical High-School at Charlottenburg. Dr. Geiger, of the M.A.N. in Augsburg, following up these investigations, succeeded in *recording the vibrations by his torsiograph.* During the war copious data from theoretical and experimental investigations on German submarine engines were collected by the Admiralty.

From these investigations two conclusions were drawn: (1) It is possible to design shafts for marine oil-engines that will run without dangerous vibrations up to the highest speed of the engine. For a six-cylinder engine, e. g., this means that the critical speed of the second grade and 6th order be 20 per cent. above the maximum engine speed. (2) If there remain any dangerous critical vibrations within the working range of the engine it is possible to shift them as far below the normal speed as necessary. When running the critical spheres must be avoided and passed over very quickly.

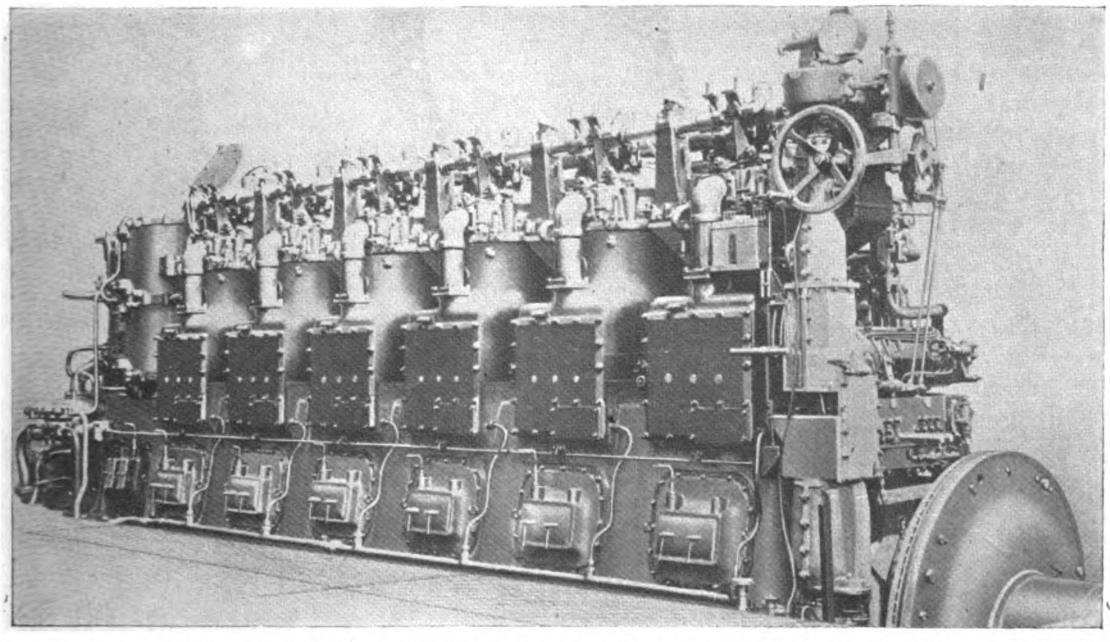


FIG. 2. Krupp 1100 shaft h. p. two-cycle submarine Diesel engine of the port-scavenging type

Conclusion 1: generally calls for an exceptionally strong crankshaft, short cylinder distance, low stroke to bore ratio and an arrangement of the flywheel immediately behind the last bearing of the engine. It is highly desirable, that directly reversible marine engines should be free from vibrations, for the critical engine speed, if falling within the working range, always must be passed in maneuvering and the engine, owing to the resistance of the screw might be unable to get over the critical sphere and might break the shaft. For dynamo driving, engines, having highly sensitive governors and freedom from vibrations are most valuable.

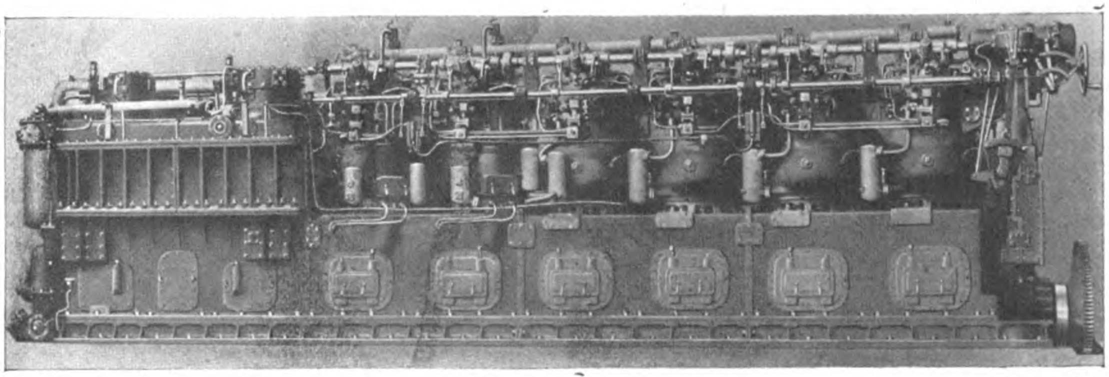


FIG. 3. Krupp 1650 shaft h. p. two-cycle submarine Diesel engine of the valve-scavenging type

Conclusion 2: generally can be secured with every plant having a normally dimensioned crankshaft by arranging a suitable revolving mass at a certain distance behind the last bearing of the engine. Efforts are being made with the object of neutralizing the critical vibrations of engines. The methods being employed by the Germaniawerft and others are founded on the same principles as the oscillation-tanks of ships.

Lubrication

In general, marine engines of the trunk-piston type as well as of the cross-head type nowadays are fitted with forced lubrication. Only by these means was it possible to reduce the wear and tear of marine oil-engine bearings, these being under a higher specific pressure than those of steam-engines. Since unexpected troubles are not to be feared with a thoroughly good system of lubrication, shipowners have put up with the disadvantages of enclosed engines.

In Germany the investigations of Prof. Gümbel have brought about a remarkable progress in lubrication. In his work, based on that of Osborne Reynolds, he shows how bearings are to be built in order to obtain fluid-friction instead of the rubbing of insufficiently lubricated surfaces. The means advocated are: properly dimensioned shaft-bearings, supply of the lubricating-oil at the point of least pressure, absence of oil-grooves in the most loaded part of the lubricated surface and the production of a wedge-shaped oil-film.

The principal cause for the quick wear of bearings is the presence of dirt and water in the lubricating-oil. All firms make the greatest efforts to avoid this. From the pollution of the oil by sand, dust and rust, engines of the enclosed type are better protected than those of the open type. (This is a remarkable advantage of the enclosed engines.) Besides these contaminating substances, carbon is sometimes to be found in the lubricating oil. This originates from the lubrication-oil coming in contact with the hot parts of the pistons and cylinders, burning to coke and then crumbling. Engines with trunk-pistons therefore must have an intermediate bottom in the piston if the latter is uncooled. Engines of the short-piston crosshead-type are built with a drip-tray to separate the cylinder part from the driving-gear. The best protection is the cooling of the pistons.

With oil-cooled-pistons the formation of carbon arises from excessive temperatures and insufficient velocity of the cooling oil in the oil space of the hot piston-head. The fine parts of coke, working like emery, pass through the usual wire-gauze filters. To remove these contaminations from the oil, special cleaning plants for the dirty oil, or filters of felt discs, are to be arranged which serve to clean some part of the circulating-oil continuously.

The presence of water, especially of sea-water, in the lubricating-oil *is very dangerous.* In a reliable plant the circulating oil must be free of water. Water cooling-pipes and connections and screw-plugs of the water spaces are to be avoided inside the crank-chamber. Some difficulties will arise if the pistons are water-cooled. Therefore it is best to cool the pistons by oil, and as far as this method of cooling is feasible, it should be preferred.

For high-powered two-cycle submarine engines oil-cooling is not sufficient; the pistons must be water-cooled. In order to prevent the entrance of the water into the lubricating-oil, the Germaniawerft has placed the telescopic-pipes for the supply and discharge of water wholly outside the crank-pit; fig. 7 shows this arrangement for the 1,650 B.H.P. engine, fig. 3. With marine engines of the cross-head-type it is easily possible to arrange the telescopic-pipes for the cooling-water separated from the crank-case, as, e. g., in the B. & W., the Werkspoor, and the Germaniawerft-engine.

Scavenging

In two-cycle Diesel-engine practice at first the scavenging-air was supplied by *valves* in the cylinder cover, each cylinder having 1 to 4 scavenging-valves. With time, however, many difficulties arose in connection with the great number of valves in the cover. Not only did the driving gear become complicated and noisy, but above all, the cylinder-heads having so many holes tended to crack under the stress caused by the high temperatures of

*See also the paper, read by the author at the 21st meeting of the Schiffbautechnische Gesellschaft: "Die Probleme der Oelmaschine und ihre Entwicklung auf der Germaniawerft in Kiel" in the "Jahrbuch der Schiffbautechnischen Gesellschaft" 1920, publ. Julius Springer, Berlin.

the two-cycle process and therefore had a short term of life.

There was no other way left than scavenging by means of *ports* as first employed with hot-bulb engines. This method was introduced for Diesel-engines first by Sulzer Bros. The Germaniawerft has built several engines, e. g., those of fig. 2 with port-scavenging. Some experiments in connection with scavenging made by Direktor Regenbogen, of the Germaniawerft, have shown that with properly dimensioned and shaped scavenging ports and pistons, a nearly complete washing out of the inner cylinder can be obtained. *The experiments were made with a glass cylinder and a fixed and moving piston of wood.* Fig. 8 demonstrates the experiments after this method. By saw-dust blown into the stream, the movement of the air was made visible.

The scavenging experiments in the glass cylinder and actual tests with the engines, fig. 2 have shown, that considerable mean-indicated pressures and therefore high power can be secured without filling up the cylinder with scavenging-air after the closing of the exhaust ports.

The port scavenging two-cycle engine therefore has come to the front, and will displace the valve-scavenging engine in the future.

Process of Combustion

Among the oil-engine problems most in need of being cleared up, the process of combustion stands first. As long as it is impossible to deliver a new engine of any class for a given fuel without lengthy and expensive empirical adjustment on the testing-bed, we cannot be satisfied with the condition of oil-engine building.

According to our to-day's knowledge, the process of combustion is divided in four phases, distinctly separated from one another. These are *injection, gasification, ignition* and *combustion.*

In oil-engine building, three methods of injection have become important:

(a) *Injection by compressed air.*
(b) *Solid-injection.*
(c) *Injection by ignition in a small chamber connected with the combustion space.*

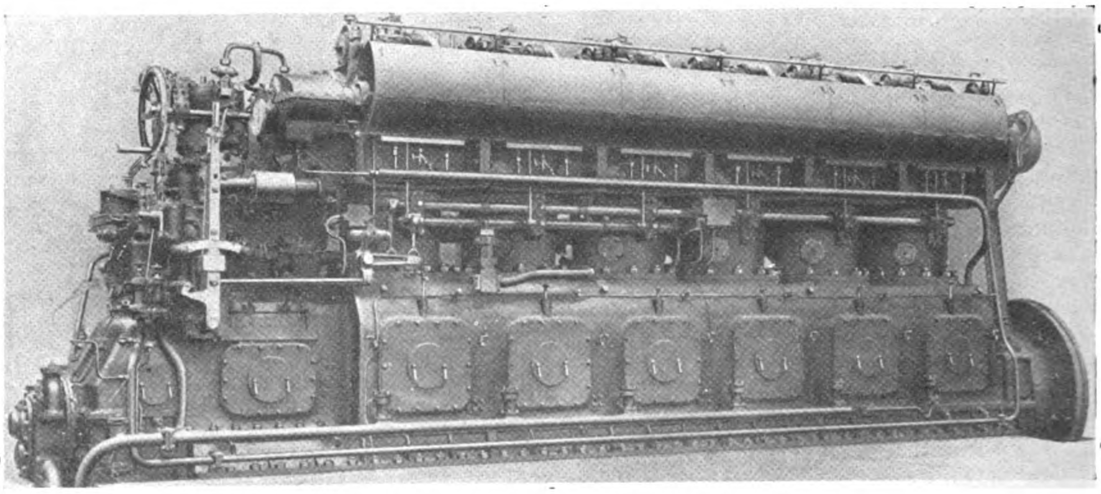


Fig. 4. Krupp 1,200 shaft h.p. four-cycle submarine Diesel engine.

The injection by air, introduced by Diesel himself, is preferred in Germany. For this method an air-compressor for the generation of the spraying-air is necessary. The compressor is suitably driven directly by the engine. By the application of a three-stage compressor with piston-or-plate-valves, difficulties with the compressor are completely overcome.

The engines (b) and (c) are of the so-called compressorless type. Injection by air is also possible without an air-compressor by taking the spraying-air from the working cylinder. This system has not become important, as the hot-air from the cylinder gave trouble.

The solid-injection was employed first in England by the firms Vickers, Crossley, and in America by De La Vergne.* This method being generally known to the readers of "Motorship," it need not be mentioned here.

The injection by ignition in a small chamber has been fully developed for engines of small and medium power in Germany by *Steinbecker*†. The process is as follows (vide fig. 8): A portion of the fuel is brought into the shot-channel between the small chamber and the working-cylinder by the fuel-pump in the cylinder cover, 3° before the upper dead-center. Through the air streaming from the cylinder to the chamber a part of the fuel is blown into the same. As the temperature in the chamber corresponds to a pressure of 30 atm. (430 lbs. per sq. inch) the fuel ignites here and the pressure rises to 65 atm. (930 lbs. per sq. inch). The high-temperature-high-pressure gases now streaming back through the shot-channel to the working cylinder completely atomize the rest of the fuel which the fuel-pump has pressed into the shot-channel.

(To be Continued)

*[Now adopted by Ingersoll Rand Co.—**Editor.**]

†[We shall shortly publish an article on the Steinbecker engine.—**Editor.**]

"DRENTE" A DUTCH SURFACE-IGNITION ENGINE TANKER

"Drente," an oil-carrying twin-screw barge of 1,254 tons gross, built in 1908, has been fitted with two 4-cylinder Kromhout surface-ignition oil engines. She is owned by the Nederlandsche Indische Tankstoomboot Maats of Batavia, Java, which is a subsidiary of the Royal Dutch-Shell combine.

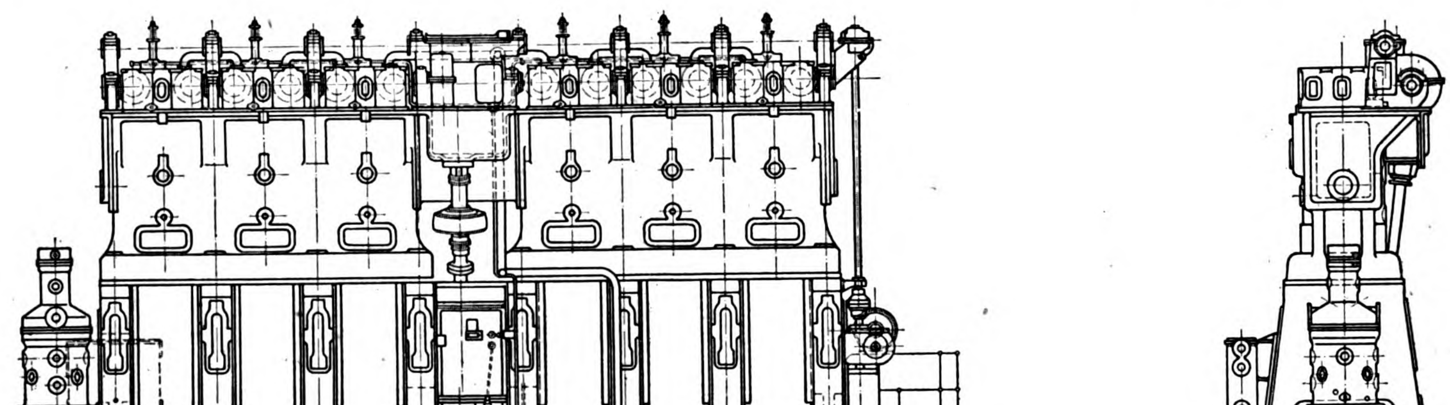
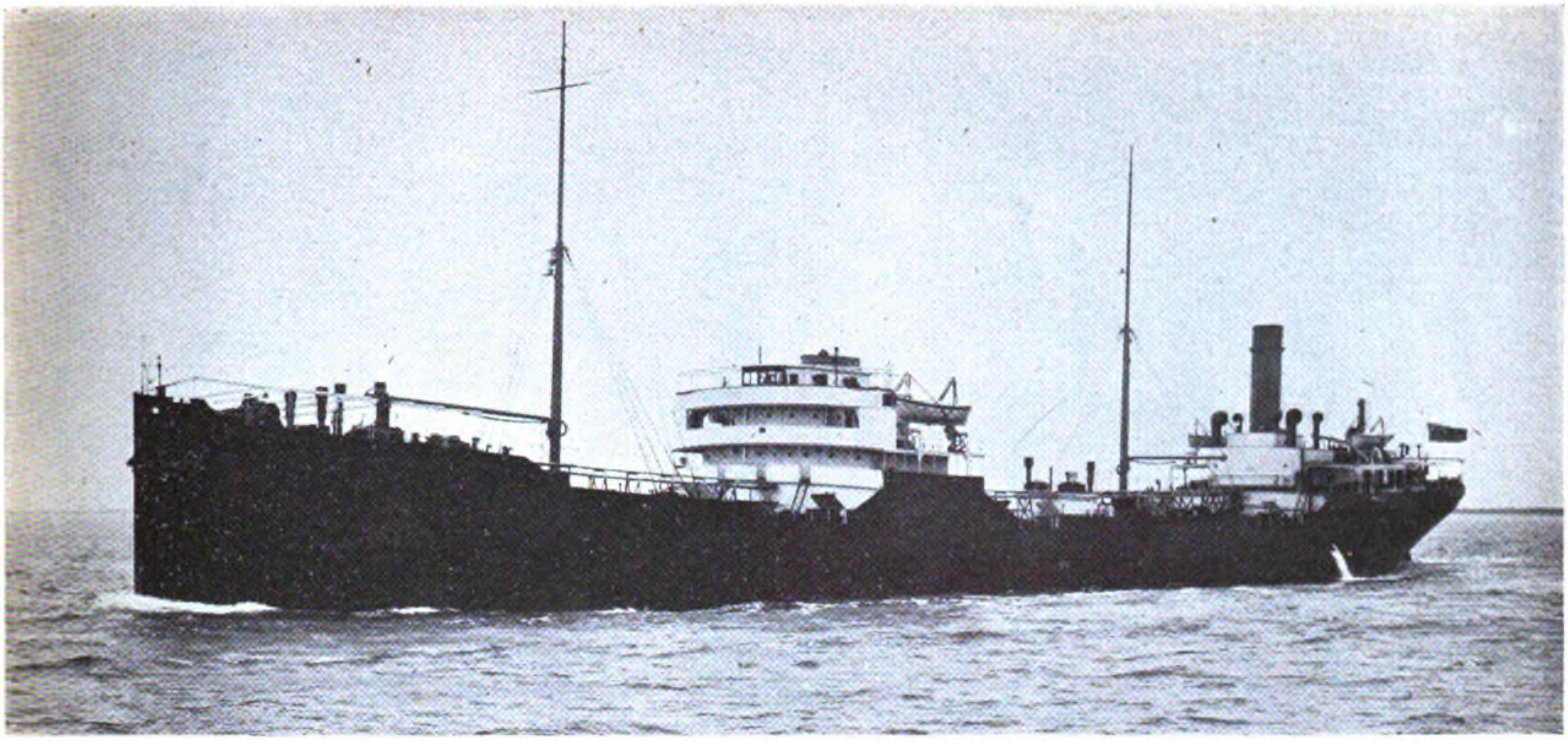


Fig. 5. A Krupp 1,250 B.H.P. four-cycle Diesel marine engine of the crosshead type, many of which are under construction



The 10,500 tons d.w.c. motor-tanker "Narragansett" built and "Diesel" engined by Vickers, Ltd., of Barrow for the Anglo-American Oil Co. A sister motorship is building for the same firm, four sister motorships are on order for Tankers, Ltd., and two for another concern. Why do American oil-companies still hesitate to take similar action?

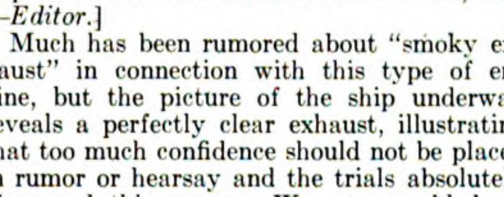
New Vickers-Engined Motorship

First of a Fleet of Eight 10,500 Tons Dead Weight Tankers Fitted With Solid-Injection "Diesel" Motors—Designed Speed Exceeded by One Knot—A Fuel Consumption of 0.385 lb. per Brake H. P. Hour

SOLID-INJECTION of fuel, or mechanical-injection as it perhaps should be termed, is a subject of increasing interest and those, who because of lack of knowledge on the subject were hitherto doubtful about the system are becoming much warmer towards it now that the great extent to which it has been adopted in Great Britain has become known, there being nearly half-a-million horse-power of Vickers solid-injection "Diesel" type heavy-oil marine engines in service. Until the end of the war, ships fitted with the Vickers-engines have been to the order of the British Admiralty, including a fleet now belonging to the oil companies, and the secrecy necessary in such contracts has prevented the general shipping public from acquiring that wider knowledge of this engine which its recorded achievements merited.

Now that hostilities are over, Vickers, Ltd., have lately been free to devote their energies to the development and construction of solid-injection "Diesel"-engines for mercantile-marine requirements. During the war many oil-tankers built for the Navy—which have since been acquired by the oil-carrying companies referred to—were fitted with Vickers oil-engines. And, the special experience which was then gained and the results achieved completed the data required for the design and construction of the latest big mercantile-ship to be fitted with their post-war type of engine. Altogether there are nearly one-dozen Vickers-propelled motor-tankers in actual service, so mercantile as well as naval service experiences are now available.

By the time this appears in print American shipowners and builders will have had an opportunity to inspect the first of the post-war Vickers-engined tankers, namely the "Narragansett," as she will have visited New Orleans and sailed again. She is the first of two 10,500 tons d.w.c. tankers built to the order of the Anglo-American Oil Company, a Standard Oil subsidiary; the other being the "Seminole" now nearing completion, and four sister motor tankers are being built by Vickers, Ltd., for the newly-formed Tankers, Ltd. (Scottish-American Oil Company, whose New York offices are at 120 Broadway). Orders have also been received by Vickers for four more 1,250 shaft H.P. Diesel-engines for other merchant-ships, making a total of eight standard motor tanks. [At a meeting held early in June, Mr. Thos. J. Callaghan, chair-



Indicator-card from Vickers 1,250 b.h.p. solid-injection oil-engine

man of Tankers, Ltd., stated that "Vickers were building six tankers for them," so perhaps the latter two are also for Tankers, Ltd. —*Editor*.]

Much has been rumored about "smoky exhaust" in connection with this type of engine, but the picture of the ship underway reveals a perfectly clear exhaust, illustrating that too much confidence should not be placed in rumor or hearsay and the trials absolutely disproved this rumor. We are enabled to publish these illustrations and details through the courtesy of Vickers, Ltd, whose New York office is at the Woolworth Building.

The motorship "Narragansett" has the following dimensions:

Displacement	14,000 tons
Deadweight capacity (maximum)	10,500 tons
Deadweight capacity (normal)	10,050 tons
Cargo capacity on 26 foot draft	9,450 tons
Fuel capacity	750 tons
Cruising radius	68 days
Cruising radius	18,000 nautical miles
Capacity of main tanks	434,000 cub. ft.
Capacity of summer tanks	52,000 cub. ft.
Total cargo capacity	486,000 cub. ft.
Length	425 ft., 0 ins.
Breadth (moulded)	56 ft., 8 ins.
Depth (moulded)	33 ft., 0 ins.
Draft	26 ft., 0 ins.
Contract speed	10.50 knots
Trial speed (on 26 ft., 2 in. draught)	11.24 knots
Brake horse-power	2,500 H. P.
Engine speed	118 R.P.M.
Cylinder bore and piston stroke	24½ x 39 ins.
Auxiliary machinery	Steam driven
Auxiliary oil engine	Vickers-Petter

The vessel is built on the Isherwood system of longitudinal framing, with ten cargo-tanks divided into pairs by a center-line bulkhead. For propulsion two 1,250 brake h.p. Vickers six-cylinder, four-cycle, single-acting, solid-injection "Diesel"-type oil-engines are installed. In this design no air-blast compressor is used for injection of fuel, the only compressed-air needed being that for starting and reversing, injection being effected by mechanical pressure alone. Air for maneuvering is supplied by a vertical steam-driven Brotherhood compressor that delivers air to 10 steel bottles up to 600 lbs. per square-inch pressure.

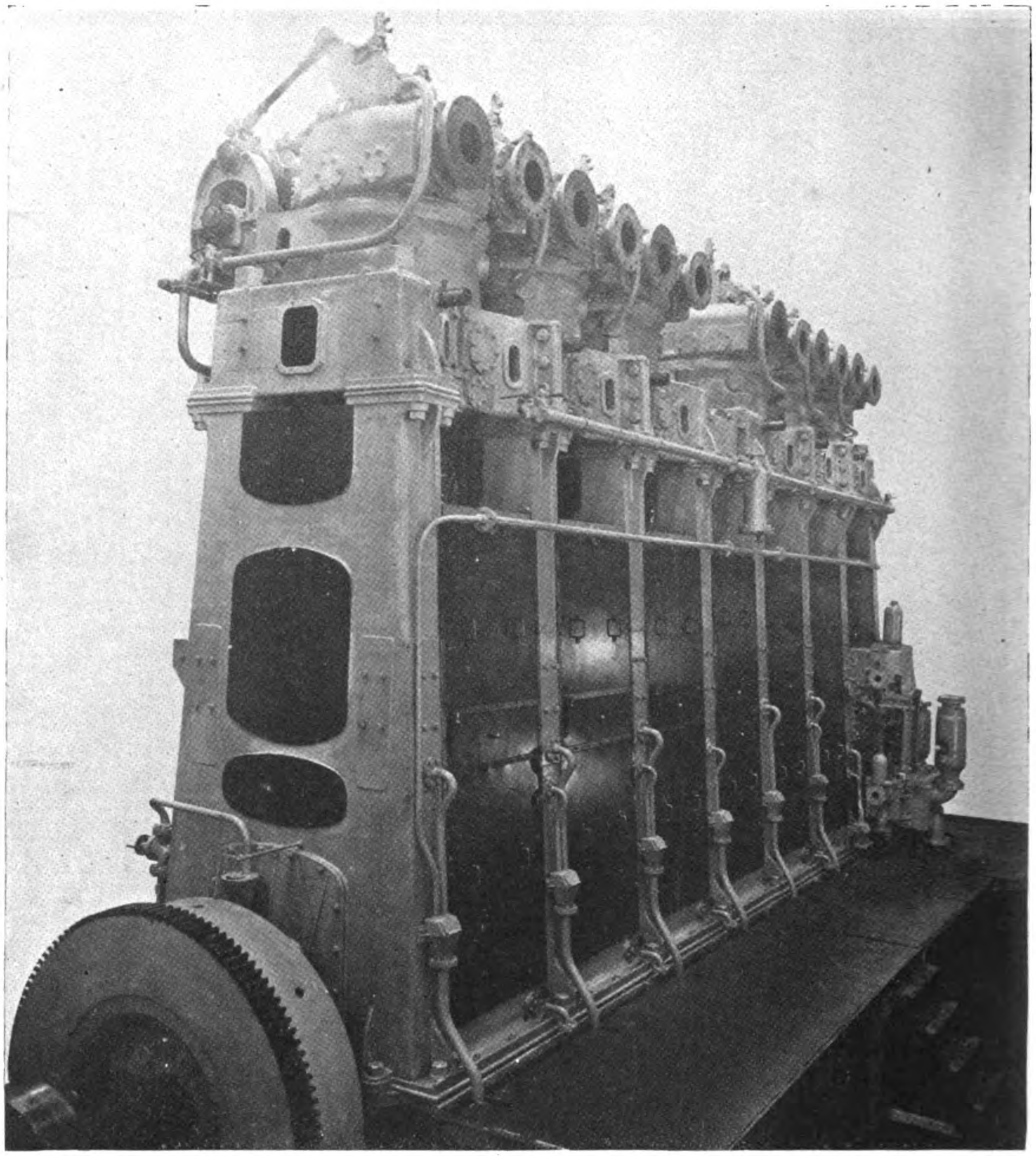
Favorable conditions held during the trials and speed runs were made over an eight-mile course with and against the tide, the trials altogether lasting six hours. A mean speed of 11.24 knots (loaded) for the 16-mile speed test was attained, bettering the guaranteed speed by 0.74 knot although the ship was ballasted down to 26 foot, 2 inches draft. At this speed approximately 2,650 brake h.p. was developed at 125.5 R. P. M., on a fuel-consumption of 0.418 lbs. per brake h.p. hour, or 10.8 tons per 24 hour day. But the consumption obtained during the two and one half hours maximum speed trial was 0.385 lb. per brake h.p. hour. The fuel used on the tests was Anglo-American Diesel-oil of 0.894 specific gravity. The exhaust was quite clear during the entire trials, and the only smoke given was from the oil-fired donkey-boiler. The compression-pressure when the attached

card was taken was 420-440 lbs. per square inch, with a maximum pressure not exceeding 500 lbs. per square inch. No vibration was noticed at any time. It is to be noted that the above fuel-consumption is equivalent to 0.33 per steam I.H.P. hour.

In the shops the first engine was tested by daily running over four weeks; but owing to the moulders' strike delaying the dynamometer gear, it was necessary to confine full-power trials to four cylinders at a time. The second engine was put on official trial as soon as it was completed owing to the urgency of delivery. She did a full day's run with all cylinders on overloaded and developed 1,350 brake horse-power at normal revolutions, and with a clean exhaust. As mentioned, the maximum cylinder-pressure during this run was maintained below 550 lbs. per square-inch, although in preliminary runs injection was advanced to give over 600 lbs. at normal load to test the engines.

The cylinders are arranged in two groups of three. Each motor is rated as 1,250 brake horse-power at 118 revolutions per minute from cylinders 24½ inch bore by 39 inch stroke. The crankshaft is built-up of two forged-steel, three-throw pieces coupled together with crank-arms set at 120 degrees, and the order of firing is 1, 5, 3, 6, 2, 4, for ahead motion, where the six cylinders are numbered from forward aft, and, considering one complete cycle or two complete revolutions of the engines, it follows that Nos. 1 and 6 pistons both move downward together, No. 1 being on impulse stroke and No. 6 on suction stroke, the other pistons working similarly in pairs.

It will be noticed that the main construction of the engine consists of hollow cast-iron columns straddling the main bearings and attached at top and bottom to the cylinders and bed-plate. The cylinders are cast separately and bolted together at the bottom to form a continuous girder. The columns support the single slipper-guides and impart rigidity to the engine, but do not carry the main impulse reactions which are taken by sixteen steel tie-rods that run through the columns.



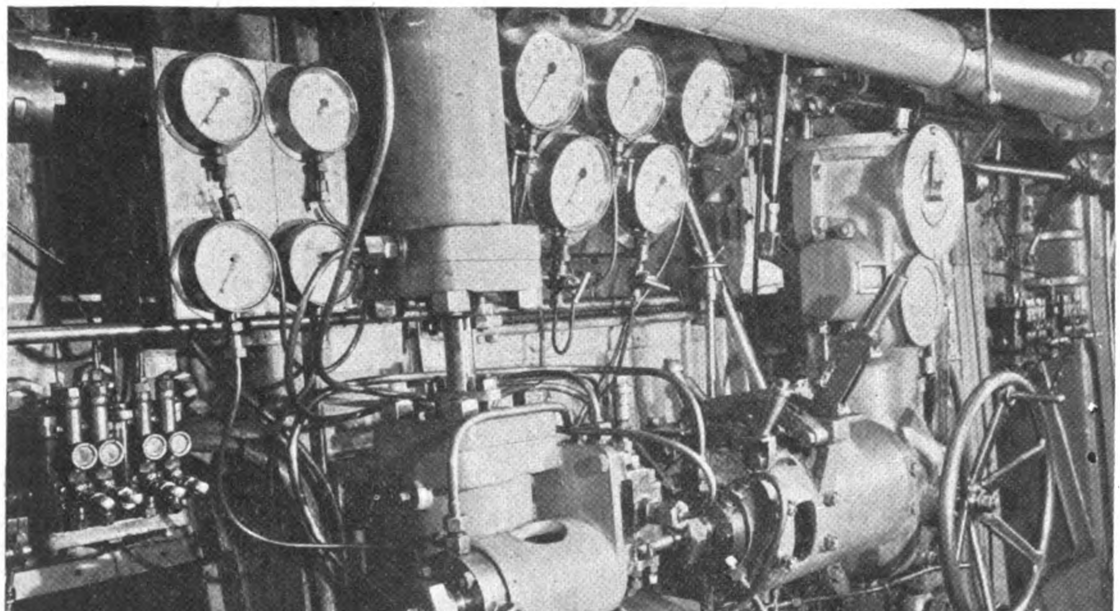
Exhaust side of Vickers 1,250 B.H.P. merchant marine oil engine

Between the groups of three cylinders is arranged the mechanism for operating the cam-shaft, this being driven off the crankshaft by means of spur and bevel gearing. On the cam-shaft the cams are mounted in pairs, giving ahead and astern motions. Immediately above the cam-shaft another shaft runs along the front of the engine, carrying the fulcrum-levers driven off the cam-shaft. These fulcrum-levers are mounted eccentrically on the shaft, so that by partial rotation of the shaft the levers of the inlet and exhaust valves can be lifted clear of the cams.

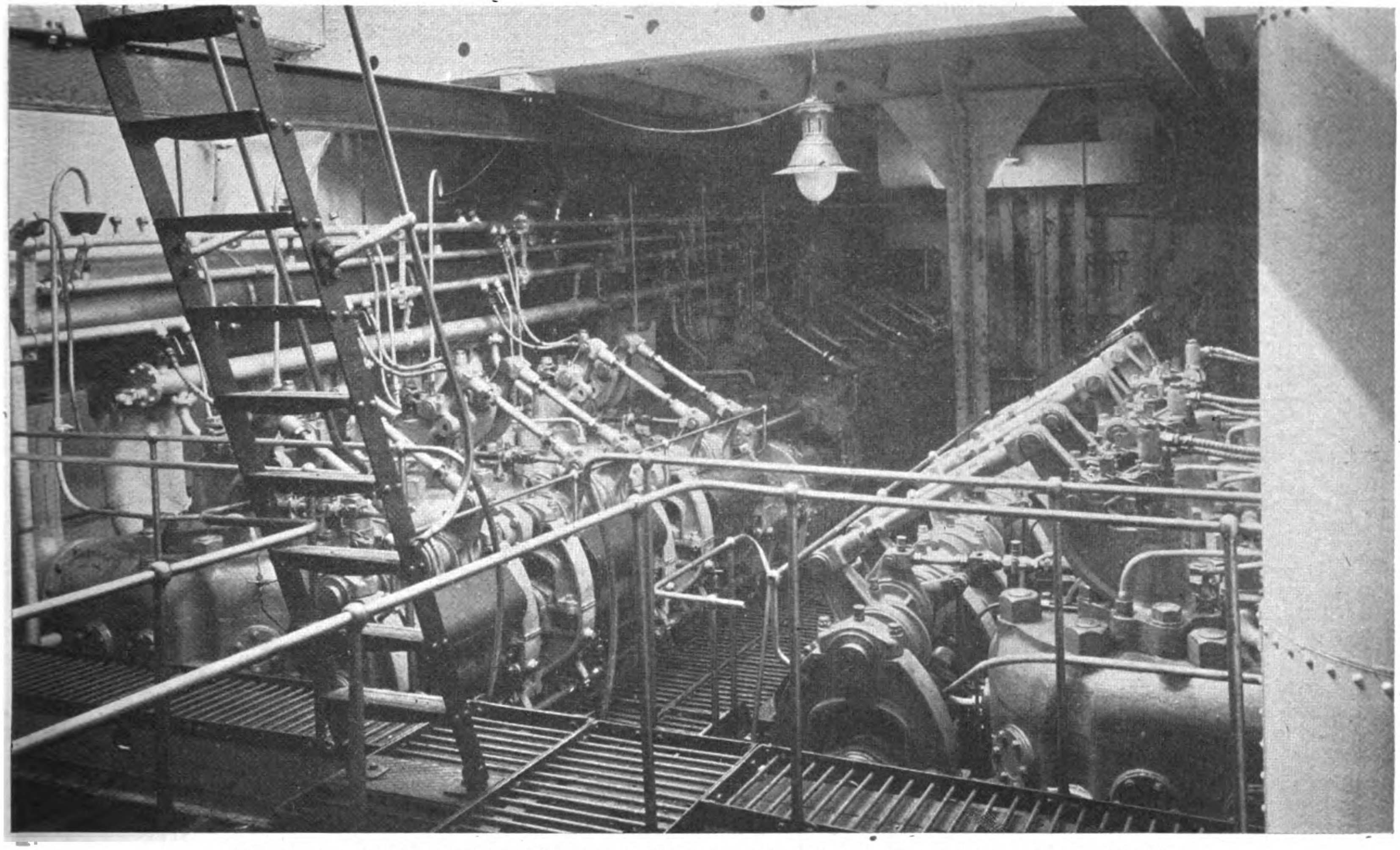
Reversing the engine is effected by a servo-motor operated by compressed-air and fitted with a dash-pot cylinder containing oil. This servo-motor rotates the fulcrum-lever shaft, thus lifting the lever clear of the cam, and a continuation of the one movement of the reversing-lever slides the cam-shaft in a fore and aft direction, thus bringing the astern cams into operation after which the fulcrum-levers are lowered, and the astern motion ensues.

A small hand-pump is provided for reversing the engine by hand. The first movement of the starting-wheel controlling the compressed-air supply to the cylinders puts compressed-air into all the cylinders; further movement of this wheel cuts off the air to the cylinders in pairs, and puts oil into the injection-valves until all the fuel-injection valves are receiving oil and the air supply is cut off.

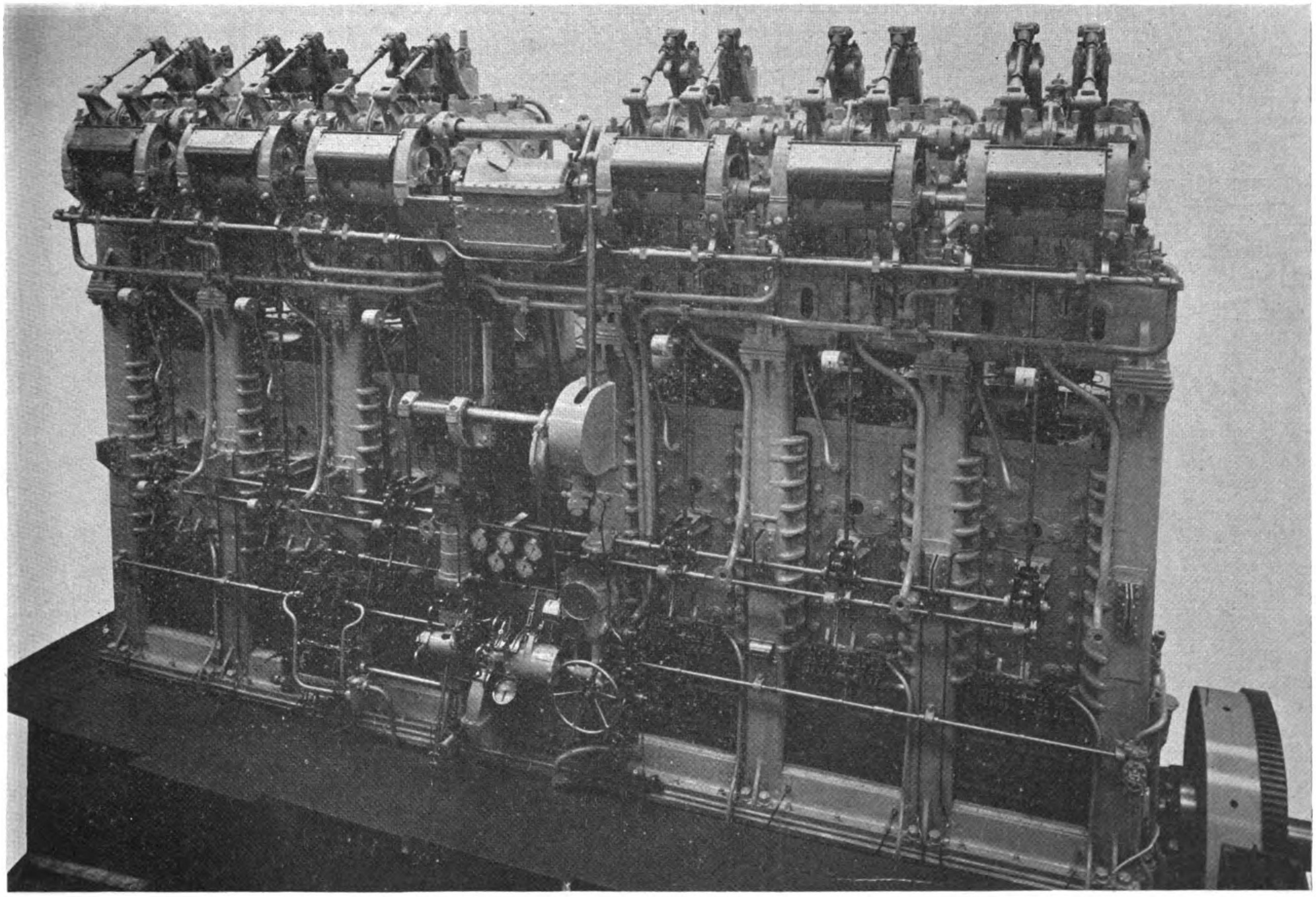
Fuel-injection is effected by means of a small four-throw pump driven by gearing off



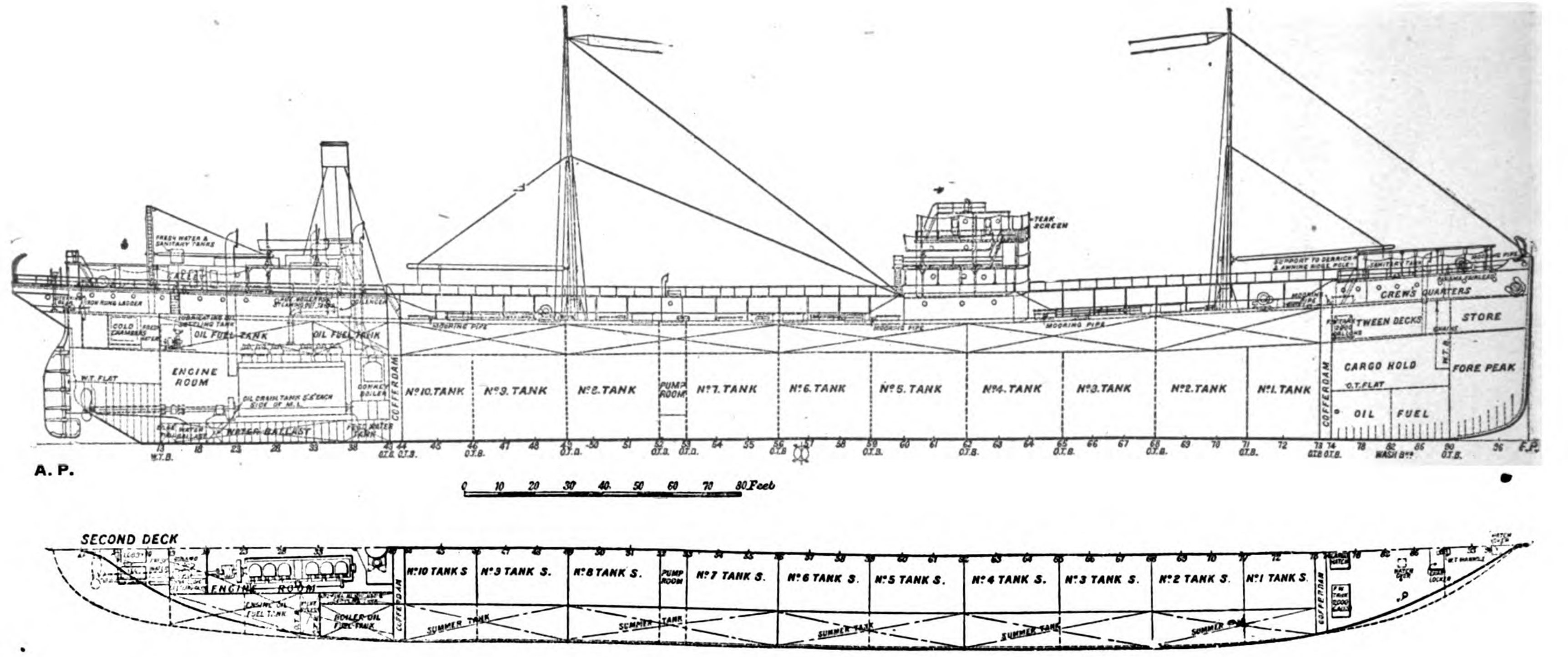
Control mechanism of the Vickers 1,250 shaft h.p. solid-injection "Diesel" type marine heavy-oil engines



Engine-room of the motorship "Narragansett" showing cylinder-heads and valve operating mechanism

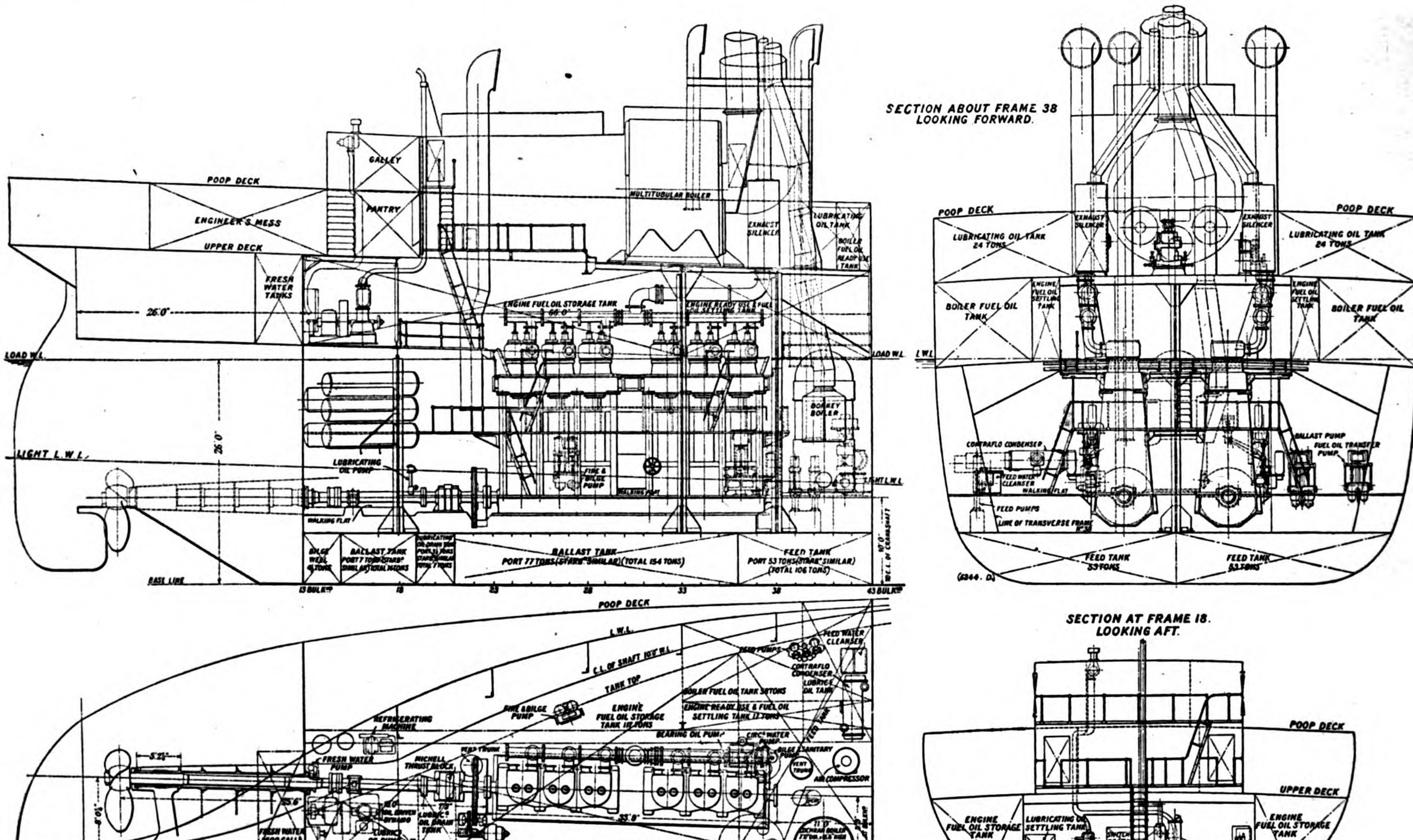


One of a pair of 1,250 shaft h.p. Vickers solid-injection, crosshead, four-cycle type "Diesel" engines installed in the Anglo-American Oil Co.'s motor-tanker "Narragansett." Altogether 16 oil-engines of this power were recently ordered from Vickers, Ltd., for tankships, an example American oil-companies could copy with benefit to themselves and to the Diesel-engine industry of the U. S. A.



General arrangements of cargo-tanks and engine-room of Anglo-American Petroleum Co.'s new motorship "Narragansett"

the cam-shaft drive. The oil is delivered—without any air—at a pressure of about 4,000 lbs. to the fuel-injection valves placed on the cylinder-head in between the air-inlet and exhaust-valves, depending on the power being developed by the engine. Each fuel-injection valve is driven by a bell-crank lever and push-rod, spring controlled, off the cam-shaft, placed at the top and front of the engine. The atmospheric air-inlet-valves and the exhaust-valves are similarly driven off the same cam-shaft. Lever gear is provided, operated from



Engine-room arrangements of the motorship "Narragansett"

the starting platform, to cut-out any fuel-injection valves separately, and also to alter the timing and period of injection, thus controlling the power developed. The air-inlet valves each take their suction from a short vertical standpipe, closed in at the top and fitted with a suitable number of narrow slots. The exhaust from the cylinders is led into a common pipe—one for each set of engines—suitably lagged, and then passes through the silencer and up the stack into the atmosphere.

Cooling of the pistons is by sea-water through telescopic pipes. They are lubricated by small sight-feed lubricators worked by ratchet-and-lever motion off one of the cross-heads. The water-cooling service is led to the exhaust-valve in each cylinder-head through flexible hoses. Driven off the cross-head are four pumps, two being for forced lubrication, and the others for water-cooling service. The lower of these two water-pumps is for the low-pressure water service, the upper one taking suction from the lower and increasing its pressure for use in water-cooling the pistons.

Steam for the auxiliary machinery has been adopted because of the necessity for providing steam in considerable quantity for heating and tank steaming purposes. The oil-pumps, already mentioned, are steam-driven as are the compressor, ballast, fire and bilge, fresh-water and other pumps. One of the two electric-light and power engines is also steam-driven, the other being driven by a Vickers-Petter surface-ignition oil-engine. There are two boilers, one cylindrical and the other vertical. They are fitted for oil-burning. There are two sets of cargo-pumps each capable of pumping 200 tons of oil an hour. Oil is drawn from the cargo-tanks through two lines of piping 10 inches in diameter and delivered into a deck line. Any tank can be filled, or emptied, independently of the remainder, and branches are fitted so that the oil may be delivered over either side. Valves for automatically maintaining atmospheric pressure in the oil tanks are fitted on the tank hatches. William Janney variable-speed gear and hydro-electrical steering gear are fitted aft, and the galley-range is fired with oil-fuel, the fuel installation being supplied by Manlove, Alliot & Co., Limited, Nottingham. At a later date we anticipate publishing complete details of the Vickers merchant-type marine engine.

Name of Ship	No. of Eng per Ship	No. of Cyl. per Eng.	Dia. of Cyl. in inches	Stroke in inches	Revs. per min.	B.H.P. per Engine	B.H.P. per Cylinder	M.E.P. on a B.H.P. Basis	Piston Speed ft. per min.
"Trefoil"	2	8	17	27	150	750	93.75	80:	675
"Marinula" ex "Santa Margherita"	2	8	20¾	33	140	1,250	156.2	79.25	770
"Narragansett"	2	6	24½	39	118	1,250	208.3	76.0	767

Comparisons between the engines of three Vickers-engined tankers.

Thrust Bearings for Motorships

Some Interesting Details Concerning the Kingsbury Design and Installation Arrangements

By H. A. S. Howarth

ONE of the most rapid marine developments in America and in Great Britain during the War was the production and adoption of an entirely new type of thrust-bearing, that is fast superseding the old horse-shoe type of thrust. The bearing that has been adopted in this country is known as the Kingsbury, the field for which has now extended to embrace practically all types of marine drives where the internal-combustion engine is the prime mover. The thrust problem is practically the same whether the motor is of the Diesel, oil, gasoline, or producer-gas type. It is influenced however by the method used for applying the power of the motor to the propeller, as indicated by the following classification:

1. Direct-reversible engines; (a) with clutch, (b) without clutch.
2. Non-reversible engines with reversing-gear and clutch.
3. Geared engines.
4. Diesel-electric drives; (a) submarine type, (b) surface-ship type.

When used with direct-reversible engines without clutches, the thrust-bearing may be placed close to the engine, the most compact arrangement being that in which it is built into the end of the engine bed-plate. This may be done in one of two ways; by placing the thrust-bearing between the flywheel and the engine as in Fig. 1, or by placing it abaft the flywheel as in Fig. 3.

A number of bearings arranged in this way are now in successful service in motorships, and many others are being built and installed on Diesel-engines manufactured by McIntosh & Seymour Corporation, Skandia Pacific Oil Engine Company, Ingersoll-Rand Co., Worthington Pump & Machinery Corporation and others.

The "Maryland" and other motorships owned by the Texas Steamship Company have thrust-bearings as shown in figures 1 and 2, except that the thrust-collars are integral with the crank-shafts.

The type of bearing illustrated by figures 1, 2 and 3 is self-lubricating and usually air-cooled. The thrust-collar, integral with the thrust-shaft, dips into oil in the reservoir below and carries it to the top, where it is distributed by a scraper that rides freely on the collar. Two thrust-segments, or shoes, bear against each face of the collar. Their pivots are in a horizontal plane, so that they will not be injured by slight springing of the shaft in a vertical plane caused by the compression and combustion pressures in the cylinders of engines of light construction. Adjustment of the shoes for equal loading is obtained by means of shims between the shoe supports and the shoes, as shown by Section C-C in Fig. 2. This may also be done by means of adjusting screws, such as employed in the bearing shown in Fig. 3.

Compared with the horse-shoe thrust the compactness of this bearing is noteworthy, and is readily seen in the illustrations of the engines.

When a clutch is used between a direct-reversible engine and the propeller, the thrust-bearing must of course be located abaft the clutch. A bearing for this arrangement is illustrated by Fig. 4. It is of the general type described with figures 5 and 10, in which the loads on the thrust-shoes, bearing against each face of the collar, are equalized automatically. The shaft-bearing is incorporated in the thrust-bearing housing, and both the thrust-bearing and the shaft-bearing are lubricated automatically by the rotation of the thrust-collar. The arrangement shown in the figure is particularly compact, and is suitable for mounting on the bed-plate extension that passes around the clutch—the shaft-bearing shown being the one directly abaft the clutch.

When the engine is non-reversible with reversing-gear and clutch, the thrust-bearing must be located abaft the whole mechanism and may be placed anywhere along the line-shaft. It will then be so far removed from the engine that the design need not be limited to the two-shoe type. In fact, when the clutch is used with a reversible engine the same condition is true. Bearings suitable for this service are shown by figures 4, 5, 10, 11 and 12. A description with each figure gives the details of construction.

Figure 5 illustrates a simple type of thrust and guide bearing combined that operates self-lubricating with the oil level carried just below the shaft. Three shoes bear against each face of the collar. The developed section shows the method

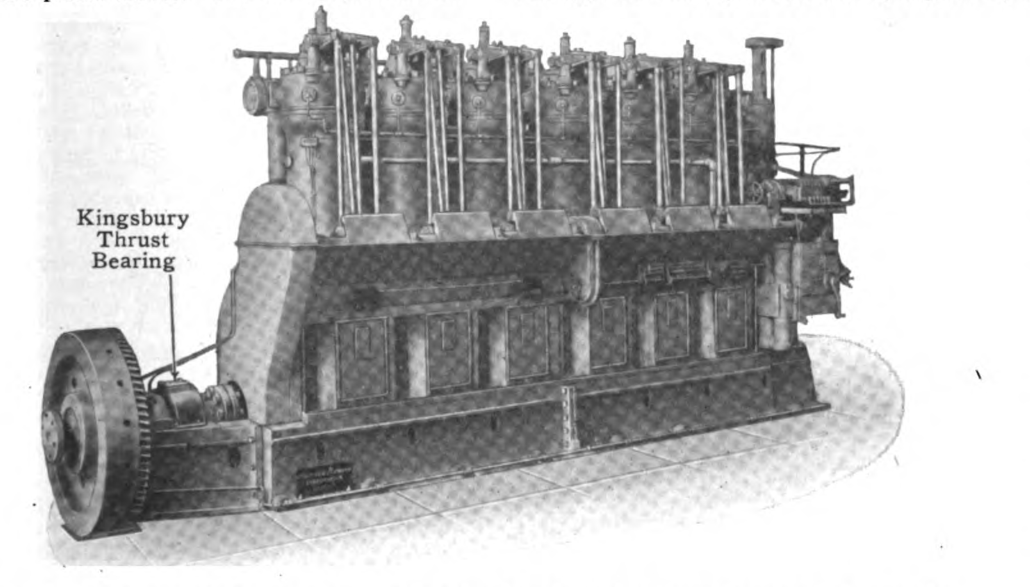


Fig. 1. McIntosh & Seymour reversible Diesel-engine with thrust-bearing between the engine and flywheel

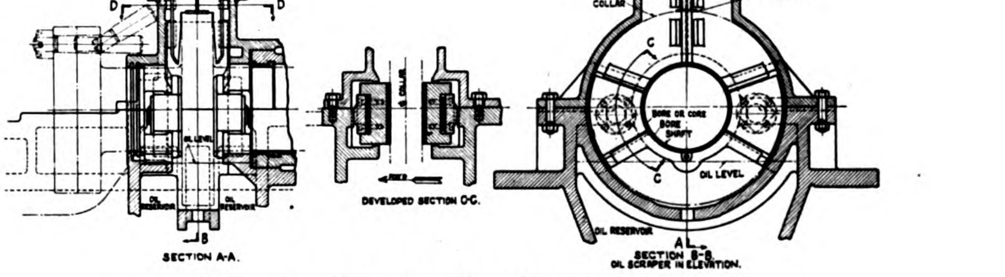


Fig. 2. Section of the thrust-bearing shown in Fig. 1

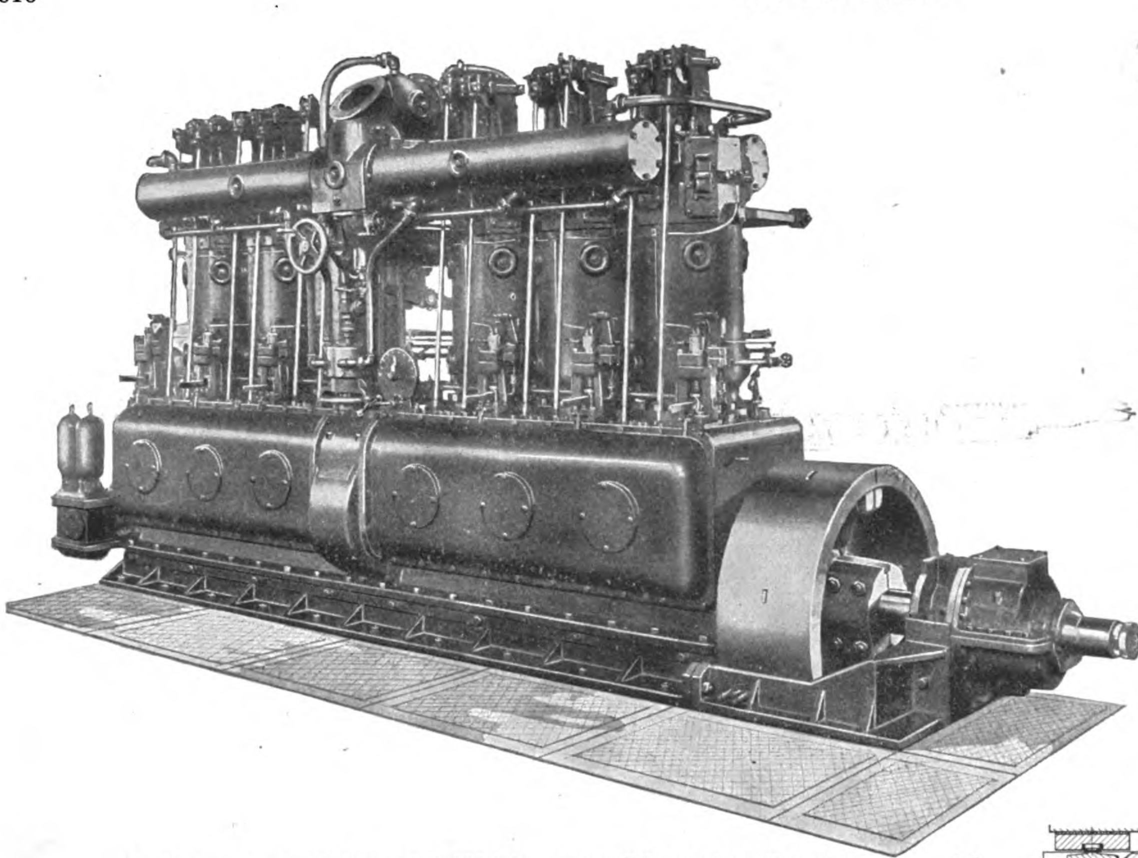


Fig. 3. Ingersoll-Rand P-R 300 b.h.p. reversible marine oil engine with thrust-bearing abaft the flywheel

of equalization, which is similar to the one employed with Kingsbury Thrust-Bearings in navy vessels.

This bearing will run air-cooled in ordinary merchant service. For severer service, it can be water-cooled. Shaft stuffing-boxes are provided when required. The housing can be provided with pads for direct bolting to after end of the main engine bed-plate.

With the geared-engine drive, the thrust-bearing, when there are no clutches or flexible couplings to interfere, may be located on the forward end of the gear-shaft if desired, using a bearing like figure 6, connected with the forced lubrication of the gear, or using any one of a number of self-lubricating bearings, one of which not otherwise illustrated is shown in figure 8.

The type of bearing shown in figure 6 is suitable for mounting on the end of a shaft, or where the thrust-collar can be held in place by a nut. The shaft of a diameter not greater than the root of the thread can, if desired, be extended beyond the housing at the right, provided precautions are taken to prevent leakage of oil from the thrust bearing housing. In Fig. 7 the details of this bearing are illustrated.

The bearing illustrated in Fig. 8 has two shoes diametrically opposite, mounted on adjusting screws, to take the thrust in each direction. It is self-lubricating, from a reservoir below the bearing. The oil may be water-cooled if necessary for high speeds.

When flexible-couplings are used between the engine and gear, and between the gear and the propeller, the thrust-bearing must of course be located abaft such couplings. Any type of Kingsbury thrust-bearing suitable for mounting along the line-shaft will do for this service, provided it is compact enough. It may be self-lubricating, and air or water-cooled, as in Figs. 5, 10 and 11, or it may be connected with the lubricating system required by the gears as shown by Fig. 9.

The bearing illustrated in Fig. 9 was designed for connection with the forced-lubricating system required by gears. Since both the guide-bearing and thrust are self-aligning, the bearing will work satisfactorily even though considerably out of line. This condition would occur in a wooden-ship in a more pronounced manner than in a steel ship. As a matter of fact this bearing was used in conjunction with Falk reduction gears on the Winton Diesel engines of the wooden motorship "James Timpson," built by the Standifer Clarkson shipyard. The self-lubricating bearings illustrated in Figs. 5, 10 and 11 can be made with self-aligning shaft bearings provided only one shaft bearing is placed in each thrust housing.

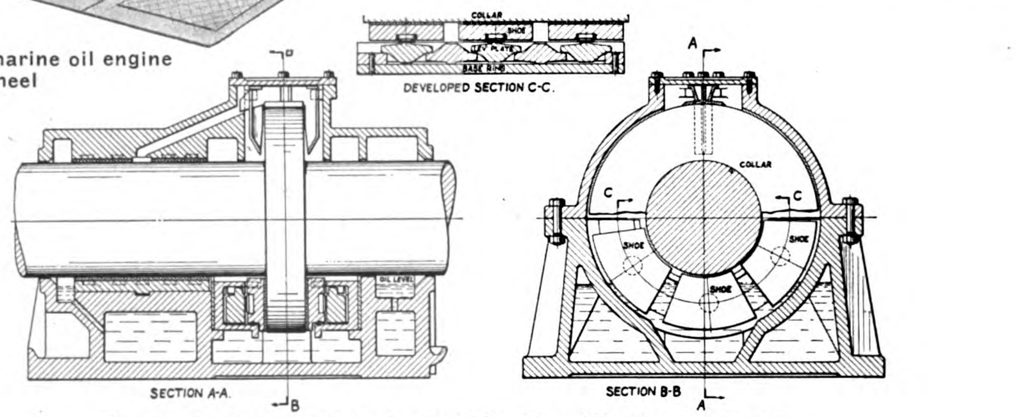


Fig. 5. Self-contained, and self-lubricating Kingsbury bearing

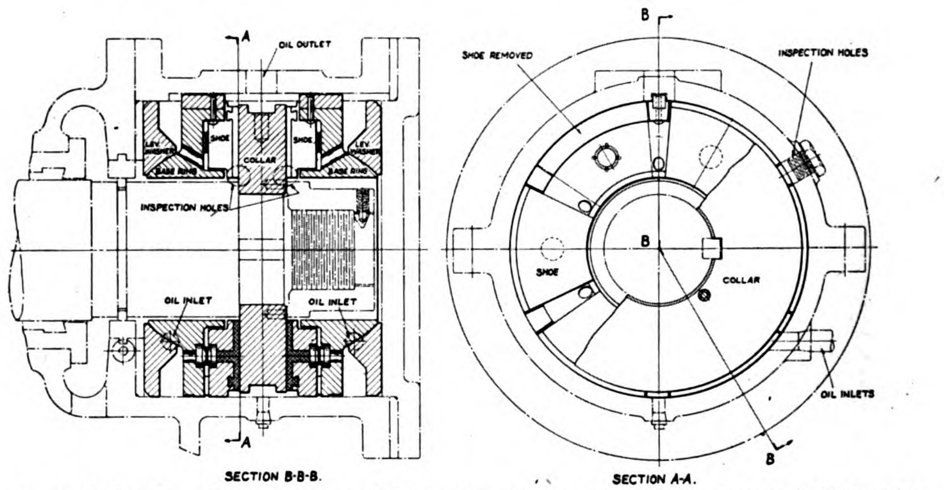
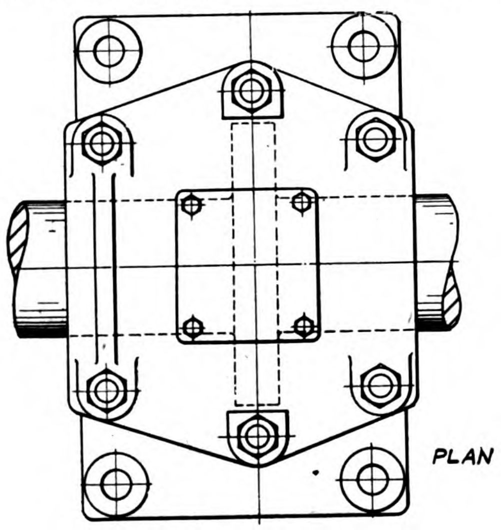


Fig. 6. Self-aligning thrust-bearing with leveling washers used with gear-reduction drive



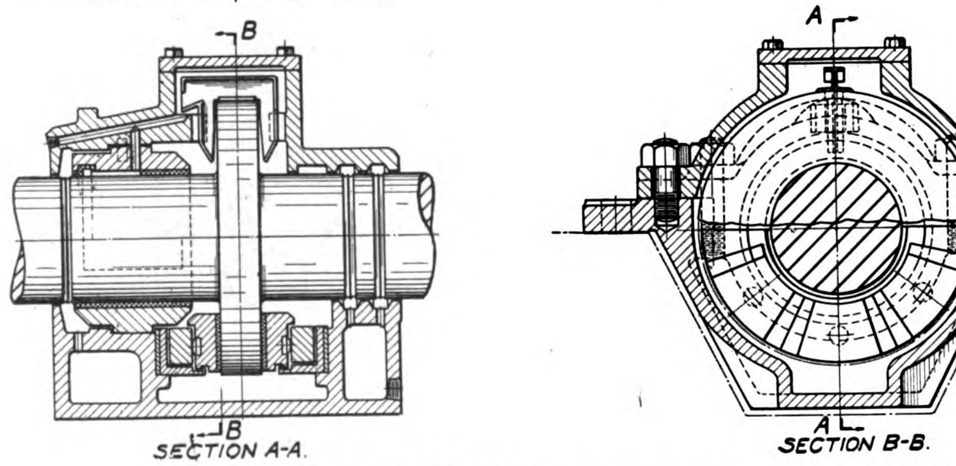


Fig. 4. Section of thrust-bearing for direct-reversible engine with clutch

For a Diesel-electric drive of the submarine type, the arrangement of the machinery is as follows: Diesel-engine, clutch, electric-motor, clutch, and propeller-shaft. Consequently the thrust-bearing must be located abaft the clutch and be of the self-contained design. Fig. 10 shows the type that is used in a number of United States submarines. Regarding Fig. 10 this thrust-bearing is self-lubricated. Being provided with stuffing-boxes, the oil can be carried at any desired level up to the top. It will automatically lubricate itself including the two guide-bearings, as long as the oil level is high enough for the collar to dip into it. In this instance the housing was split on an angle and had one high flange, so that it could be located close to the inner curved shell of the submarines for which it was designed. Although self-lubricated, this bearing was connected with a gravity oiling system as an additional safeguard that is frequently employed on war-vessels.

(To be Continued)

Double-Acting Diesel Engines

The Trend of Future Designs

By COSMOS

IT is interesting to reflect that, at the present time, almost all marine internal-combustion engines work on the single-acting principle. This cannot be regarded in any way as a final solution to the problem of economic power production on the internal-combustion principle, and progress in the future can surely be looked for in the direction of reducing weight, the space occupied, and the power output.

For guidance towards progress, it is not unnatural to look to systems of construction that which the piston and its rings can ride. The result of these expedients is that the wear is not found to be excessive.

The change of loads upon the working parts from compression and almost negligible tension with single-acting four-cycle or compression only with four-cycle engines to alternating and equal tension and compression with the double-acting principle can most readily be allowed for in the design of the main parts transmitting the piston load, as with normal steam-engine practice. The scavenging the cylinder, and to the high temperatures generated. Ingenious arrangements to sandwich layers of air between the outgoing and burning exhaust-gases and the incoming charge of combustible were only partially successful in reducing this loss. The higher temperatures required to be sustained by two-cycle engines caused pre-igniton to be a more serious problem than with the four-cycle engine.

The four-cycle double-acting horizontal engines, however, were attractive power producers, and are

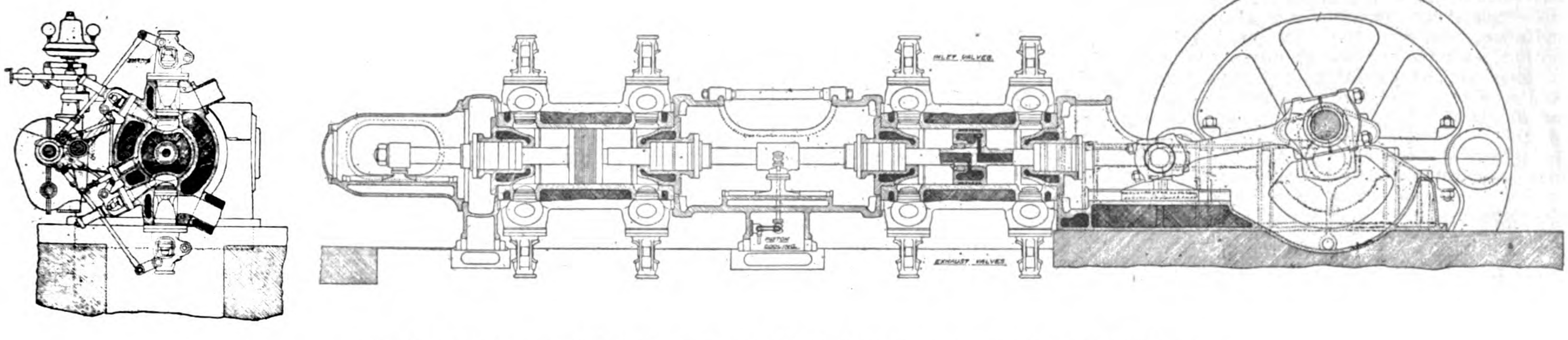


Fig. 1. Augsburg double-acting tandem 1,600 brake h. p. horizontal Diesel engine

have worked with excellent results when applied to other power producers, and in this connection the question of making the Diesel type of heavy-oil burning internal-combustion engine double-acting may be re-examined.

The double-acting principle obviously confers advantages of reduced size and weight per unit of power output that cannot lightly be turned aside. There is further a gain in mechanical efficiency and so in overall economy accruing from the smaller weights that require to be accelerated and retarded each revolution for a given power output, in addition to which the turning moment achieved is considerably improved. With all steam-engines other than the smallest, the double-acting principle is standard and universal. There have, of course, been double-acting internal-combustion engines, but the examples are very rare, and are confined practically to large tandem horizontal four-cycle engines with two horizontal cylinders and two pistons connected in tandem to a single crosshead and connecting-rod operating upon one or two cranks. This type will later be described in some detail.

It cannot be without profit to examine the progress to date with the double-acting internal-combustion engine, and to communicate the difficulties encountered.

The first obstacle to be surmounted concerns the piston-rod and gland. This gland must keep reasonably tight against the explosion pressure of the hot gases in the cylinder, and allow the piston-rod to pass through it without undue friction. The introduction into, and the exhaust of the cooling medium from the piston upon both sides of which the explosion and combustion occur and which must be efficiently cooled by water or oil, and generally for high power by water, presents a problem requiring careful design. The design and construction of a suitable gland formed of spring rings suitably lubricated has not presented an insuperable difficulty. With large gas engines this question has been solved, and the arrangements for dealing with the cooling mediums which enter through an internal pipe within the piston-rod and exhausts outside this internal pipe in the hollow-rod work satisfactorily with horizontal engines.

There is, further, the accommodation of the valves in the cylinder end already containing the piston-rod gland, which requires ingenuity to provide a satisfactory and pleasing solution. It might be feared in the case of horizontal engines that the extra wear of the cylinder liner due to carrying the weight of the piston and its rod, would prove an expensive running charge. The piston-rod carrying the one or two pistons is given permanently a slightly upward deflection so that it tends, when under the action of the weight of the pistons, to keep in an exactly horizontal plane and the lubricating-oil under pressure is forced into the cylinder at the bottom to give a film of oil upon

alternating load has certain, although unimportant, advantages in facilitating the entrance of the lubricating-oil to the main bearings, and whilst with the single-acting engine the crosshead thrust changes over from the one side to the other every revolution, with the double-acting the problem of carrying this load is somewhat simpler and is quite analogous to the double-acting steam-engine in that the thrust is always on the same guide for the direction of rotation under consideration.

With the two-cycle double-acting engine utilizing one series of exhaust ports for the exhaust from both ends of the cylinder, there is the further disadvantage that the metal around these parts is subject to twice the number of temperature

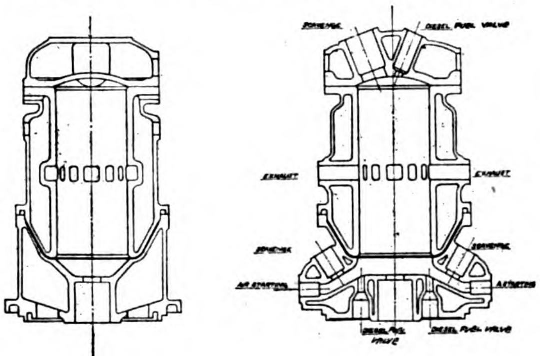


Fig. 2. Cylinder of Nurnberg double-acting Diesel marine-engine

alternations per minute that apply to the single-acting principle. Similarly the piston is subjected twice per revolution to the heat of combustion.

During the transfer of gases from the cylinder in the short exhaust period of the two-stroke cycle, very high velocities occur and the rate of heat transference from these gases to the cylinder must on this account be exceedingly high, although the actual temperature of these gases, during exhaust, may be relatively low.

With single-acting engines the cylinder is quite free to expand longitudinally under the influence of rise of temperature. With the double-acting principle the average temperature of the liner will be higher, so means must be foreseen to allow it to accommodate itself to this temperature without undue stress.

These then are the main points confronting the designer. What has been achieved to date?

Successful gas-engines have been built on the double-acting principle, but this applies only to four-cycle engines and almost exclusively to horizontal engines. Two-cycle gas-engines of all types, single and double acting, have had a very limited success, due to the relative inefficiency largely on account of the inevitable loss of the charge when

still a satisfactory proposition under favorable circumstances. The horizontal single line arrangement undoubtedly lends itself to a good disposition of valves and valve gear. The inlet-valves are placed vertically at the ends of the cylinder with the exhaust-valves directly underneath, discharging into an exhaust-pipe and silencer and ducts underneath the engine. The shaft driving the valves through cam or eccentric gear runs parallel to the main cylinder axis being driven by gearing from the crankshaft.

The success of these engines led Diesel designers to consider a similar lay-out of engine. The Diesel was first and is still much more highly developed as a vertical than as a horizontal machine. Both arrangements have distinct advantages. The vertical takes up less floor area, requires less volume of foundations, although demanding considerable headroom, whilst the horizontal makes possible the tandem arrangement of cylinders, facilitates piston withdrawal for examination and requires very little headroom. The horizontal tandem type is only suitable for moderate speeds of revolution due to the large masses necessarily involved.

As showing the state of development of the double-acting four-cycle Diesel engine, an illustration of the Maschinenfabrik Augsburg Nuremberg engine is given (Fig. 1). A considerable number of such engines have been built and have given good service. The power per cylinder end of the engine illustrated is some 200 B.H.P., but such engines have been built giving 400 B.H.P. per cylinder end. From an inspection of the drawing, the design and construction of the engine will readily be followed. The cylinder and jacket are cast in one piece. The liner is not free to expand and certain stresses are inevitable due to the liner running at a considerably higher temperature than the outside jacket. The inlet and exhaust valves are accommodated in cages passing through the cylinder end suitably water cooled, and carrying the gland-box.

The attachment of this cylinder end to the main cylinder body by a simple flange even if made of cast-steel is not sufficiently strong.

The end view shows the pocket that is available for compression space and for injection of the fuel and indicates clearly that the problem of satisfactory combustion will not be easy of solution. The slippers, guides, crossheads, piston-cooling arrangement, framing, bedplate, etc., are in exact keeping with standard horizontal gas-engine practice.

When the application of Diesel engines to warships was being considered, the two-stroke-cycle engine was in the ascendant for marine work, and experiments with double-acting two-cycle engines were undertaken. A large vertical engine with three double-acting, two-stroke-cycle, cylinders was designed and built to develop 6,000 shaft H.P. Trials were carried out in the builders' works at

Nuremberg but with what results has never been disclosed. It may be remembered that serious accident incurring loss of life occurred and put an end to this movement. As announced at the time this accident had no connection with the Diesel principle and was concerned with the scavenging arrangements.

Inflammable vapor was drawn into the scavenging-air pumps, thence passed to the scavenging-air valves in the cylinder head. On the accidental sticking open of these valves the scavenging-air reservoir was put into communication with the hot contents of the cylinder. Ignition of this inflammable vapor took place and explosion resulted, setting fire to the temporary wooden scaffolding and screens for secrecy disposed around the engine and saturated with fuel-oil. This, I believe, is the exact cause of this accident which had the result of completely stopping similar constructions, and suspending further experimentation as the war commenced very shortly afterward.

The design of the cylinder of this engine is given in Fig. 2. The design in one piece and the extremely intricate nature of the casting of the bottom end would make for unreliability. The one relatively large scavenging-valve in the cylinder head and the two small valves in the bottom cylinder end would only serve to introduce a very limited quantity of fresh-air each cycle, and would restrict the power output which would be obtained. A high pressure of scavenging-air would no doubt be carried which has been found to give a low scavenging efficiency. This engine was undoubtedly much before its time, although it has been the basis of a certain amount of development. There is a German motorship, the "Fritz," which is fitted with twin Blohm & Voss—M.A.N. double-acting, three-cylinder, two-stroke cycle Diesel engines each designed to develop 900 B.H.P. at 120 r.p.m., which were described in the April, 1920 issue of "Motorship." The cylinder sizes are approximately 18 ins. diameter by 28 ins. stroke, so that it is quite improbable that 900 B.H.P. could be maintained.

The corresponding figure for mean-effective-pressure would be 75 lbs. per sq. inch, which is too high for this design of scavenging for continuous running. A cross section of this engine is shown in Fig. 3. The cylinder design with this engine is an improvement upon the larger and earlier engine. The cylinder is in two halves, the cylinder head resembling usual early two-stroke cycle engine practice, with, in addition to the fuel, starting-air and relief valves, two scavenging-air valves. The arrangement of the cylinder end at the bottom of the cylinder is very similar to that of the M.A.N. four-cycle engine (see Fig. 1), except that the exhaust and inlet valves are replaced by two scavenging-valves, which, since the engine is a vertical one are, of course, horizontal instead of vertical. In my opinion this engine was not particularly successful..

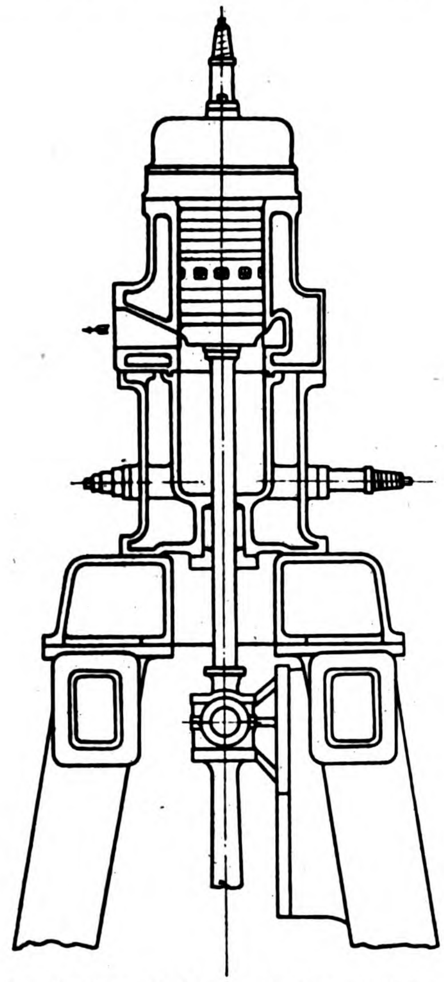


Fig. 3. Section of Blohm & Voss double-acting Diesel engine of motorship "Fritz"

So much for experience to date. What of the future?

For small and medium sized internal-combustion engines usually of the trunk-piston type, the necessity for the development of a double-acting engine is not so urgent. The larger the engine the greater the necessity to progress towards reduction in weight, space occupied and first cost—considerations which are today restricting greatly the application of Diesel engines to the propulsion of ships of other than limited horse-power. The position of the four-stroke-cycle single-acting engine is rapidly being consolidated, and it is sure that designers will not rest content with successes in this field, but will turn to the question of securing an impulse every revolution instead of every second, as is largely the present position. There are two alternatives, either the two-stroke-cycle or the double-acting four-cycle engine.

Double action presents less difficulty when concerned with the four-stroke cycle principle than with the two-cycle, and it is in such direction that we can confidently look with the anticipation of seeing serious efforts made in the early future to cope with the problems involved. That there are difficulties, greater in the case of the vertical than the horizontal engine, will probably be revealed when a solution is attempted. For marine work the vertical double-acting two-stroke-cycle reciprocating-engine represents in the light of our present knowledge, the highest point of attainment until such time as a satisfactory internal-combustion turbine is evolved. It appears to me as more sound policy to attempt to reach this stage through the intermediate step of the double-acting four-cycle engine and the single acting two-cycle engine than to attempt to bridge in one step the great gulf between the present practice and the two-cycle double-acting engine.

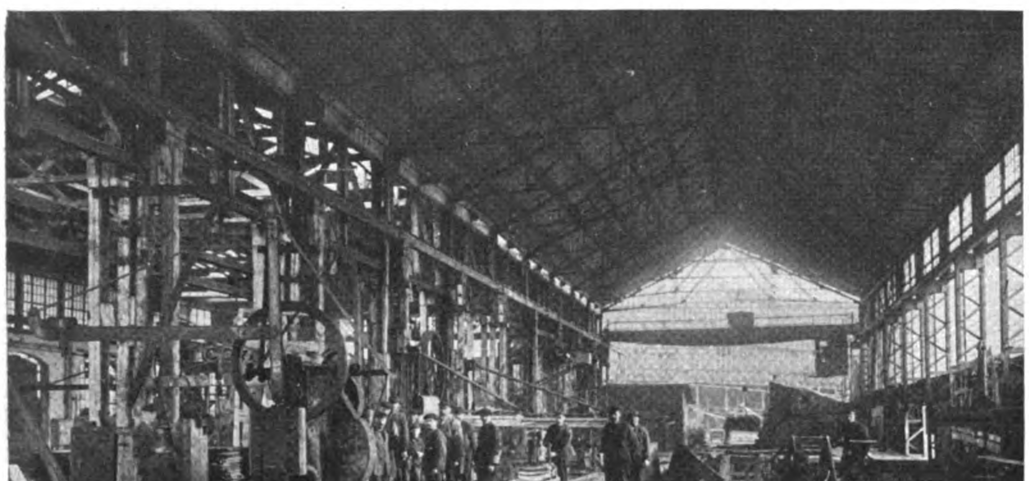
COSMOS.

A DESIGN WITH POSSIBILITIES

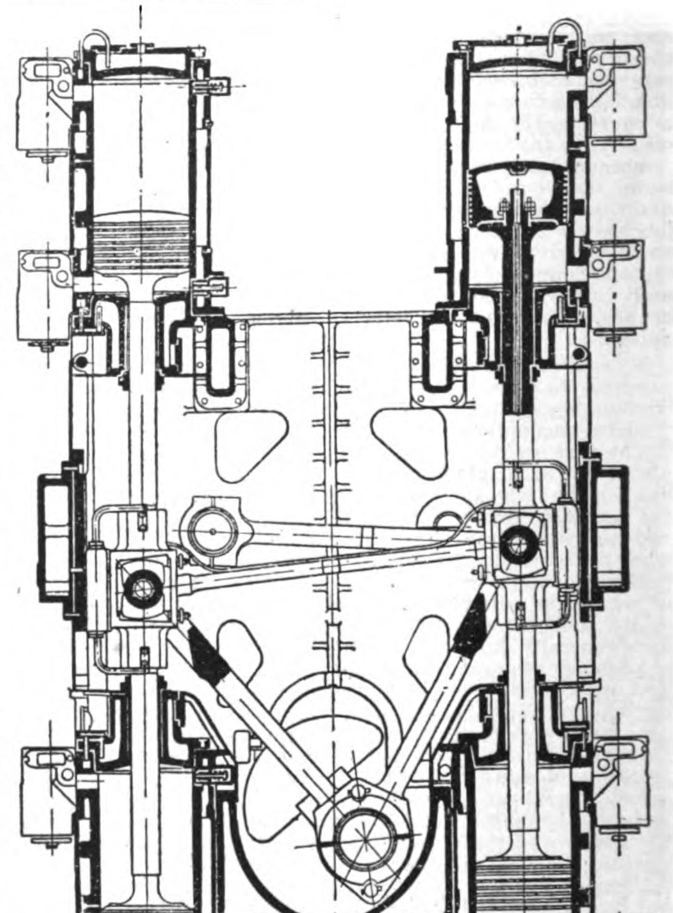
Because of the possibilities that there are in a development of marine Diesel-engines along similar lines by some enterprising firm, we publish a design of a new gas engine recently completed by the Premier Gas Engine Company, of England, from designs of J. H. Hamilton. The engine is now in operation at the iron works of Alfred Hickman, Ltd., Wolverhampton. It is of the 4-cycle type and develops 1,000 shaft h.p. at 125 R.P.M., the cylinders being 24¾ inches in diameter by 30 inch stroke. The mean effective pressure is 66 lbs. per square inch, the piston speed being 625 feet per minute. Including a generator alongside of the flywheel the dimensions of this engine are 18 feet by 25 feet with a height of 20 feet.

COST OF MOTORSHIP OPERATION

The Transatlantic Steamship Co. find that their Götaverken-built, Burmeister & Wain Diesel type 12½ knot 9,400 tons motorships show a cost of transporting 1 ton of cargo a distance of 1,000 sea-miles to be 24.60 kroners, compared with 42.40 kroners for their steamships. The cost of repairs of the East Asiatic Co.'s motorship fleet (15 vessels) during 8 years has only amounted to about 3½ million kroner, which compares very favorably with steamships. The present price of Danish-built B. & W. engines is about 600 kroner per I. H. P.



The plate-shop at the Götaverken motorship yard, Göteborg, Sweden



The 1,000 B. H. P. Premier gas-engine. Advavntages of space and weight suggest a modified marine heavy-oil engine along similar lines

Further Statements Before the Senate Committee on Commerce

Judge John Barton Payne's Evidence

(Ex-Chairman U. S. Shipping Board and Now Secretary of the Interior)

Senator RANSDELL: I got a letter the other day from a shipping magazine in New York, in which it said it was entirely feasible to convert coal into oil and use the Diesel engine, in an efficient manner. I gave you the letter, Mr. Chairman. I was wondering if you had looked into that question at all.

Mr. PAYNE: We have looked into the Diesel engine a good deal, but I have not thought of converting coal into oil in connection with the engine.

Senator RANSDELL: That is what this letter said, that it was entirely feasible; that it was not necessary to have any trouble about oil, because you could always get it out of coal.

The CHAIRMAN: Are you constructing any ships with the Diesel engine?

Mr. PAYNE: We have had conferences with reference to the Diesel engine. It is rather a difficult problem. I do not regard myself as competent to discuss it.

The CHAIRMAN: Who of the Shipping Board would be competent?

Mr. PAYNE: Mr. Hague.

The CHAIRMAN: Have you gone far enough to determine whether or not the Diesel engine is a good thing?

Mr. PAYNE: It is an excellent thing, if handled properly, but it is extremely difficult to get it operated by the ordinary personnel.

The CHAIRMAN: In order to make it effective you think we should have some men especially trained for it?

Mr. PAYNE: Yes, sir.

The CHAIRMAN: Would it not be a good idea for us, in connection with our recruiting stations, or independently of them, for that matter, to take steps to train people along these special lines?

Mr. PAYNE: If you want to know all about it, I would rather you would ask somebody who understands it better than I do. Mr. Donald knows a good deal about the Diesel engine. We have brought them over, *but we have never gone very far with it. It does not seem to hitch up, for some reason.*

Senator NELSON: The parent country for the Diesel engine is Denmark, and it is still in the experimental stage there. They have only applied it occasionally in small sizes. I have kept track of that. The Diesel engine comes from that country, and they have attempted to use it on those small concrete ships, from 300 to 500 tons, but they have not yet determined in Denmark the availability of the Diesel engine in large commercial ships; have not adopted it yet.

The CHAIRMAN: I think you are mistaken about that.

Senator FLETCHER: They are using it on 6,000 and 8,000 ton ships.

Mr. PAYNE: The only one we have is a large one.

The CHAIRMAN: Is that successful?

Mr. PAYNE: It is not installed.

The CHAIRMAN: Some one testified before the committee a few days ago that some company had a license for the construction of these engines.

Mr. PAYNE: Commissioner Scott can tell you a good deal more about that than I can.

The CHAIRMAN: Mr. Scott, can you tell us anything in regard to that? I think it was the Cramp Co.

Mr. SCOTT: I think the Cramp Co. has a right, also the Submarine Boat Co. They have the right. I think the question of the installation of the Diesel engine is in connection with the electric drive, which makes it possible to install it in a small unit, and would be much more successful than in a large one. They put in a number of them.

[We suggest that Mr. Scott, as Commissioner of the U. S. Shipping Board, should be familiar with the fact that many American firms are engaged in Diesel engine construction.—**Editor.**]

The CHAIRMAN: It seems to me it is an important matter and one we should give special attention to, especially in regard to increased efficiency and supply of oil.

Mr. SCOTT: I believe the electric drive with Diesel power would be efficient and most economical. I believe that will be developed in a reasonable time.

The CHAIRMAN: Is the Shipping Board doing anything along that line?

Mr. SCOTT: Personally I have been watching it closely on behalf of the board.

Senator RANSDELL: Have you been operating by electric drive?

Mr. SCOTT: Electric drive and steam power.

Senator RANSDELL: Electric drive and *steam* power?

Mr. SCOTT: Yes, sir.

The CHAIRMAN: I also have a statement from the editor of "Motorship." That is the letter to Senator Ransdell, that should go in the record. I think it would interest Senator Nelson. I am sorry he is not here. He thought these Diesel engines were used on small ships of 5,000 or 6,000 tons. They are used on the large ships, some as big as 13,000 tons, and it is expected to use it on much larger ships.

Senator RANSDELL: That refers to the change of coal into oil, does it not?

The CHAIRMAN: Yes; and the use of the Diesel engine. I would like to have that letter and clipping attached go in the record.

NEW YORK, N. Y., February 11, 1920.

The HON. JOSEPH E. RANSDELL,
Senator from Louisiana, United States Senate,
Washington, D. C.

DEAR SENATOR RANSDELL: I notice that when Mr. Frank Munson was giving his evidence before the Committee on Commerce you asked him if either coal or oil could be used in the Diesel-type engine. Mr. Munson replied that only oil could be used, as it is an internal-combustion engine.

It is very important to record that Vice-Admiral Hollveg has announced that a German syndicate under the leadership of Hugo Stinnes has been formed, which already has very closely investigated the possibility of reconstructing the German mercantile marine by the use of motor ships, using fuel oil derived from coal, and that there is an excellent economic case for the motorship, and Germany could compete in technique with any other nation in the field. Also that the extraction of oil from coal will yield sufficient supply of liquid fuel, and at the same time secure the greatest thermal value of coal.

I would like to draw your attention to the fact that oil derived from coal, which is a by-product known as tar oil, has been used very extensively in Europe for the operation of Diesel engines, particularly for land installations. At first it was rather difficult to use, but this now has been overcome and can be used with very considerable satisfaction.

Hitherto it has not been used extensively in the United States because of the cheapness of crude and residual mineral oils. But should mineral oil become expensive in the future, there can be no doubt but that coal-tar oil will be extensively used as fuel for Diesel engines, both aboard merchant ships and on land.

The Diesel engine was originally designed by Dr. Diesel to use pulverized coal dust and the first engine was actually run on this fuel. But coal dust as fuel is not a commercial success, but we do not know what the future may hold.

Sincerely yours,
THOS. ORCHARD LISLE,
Editor Motorship.

Senator NELSON: Have you in use any Diesel motorships in your service?

Mr. ROSSETER: Yes, sir; we have operated Diesel motor service under the Swedish flag owned by friends of mine.

Senator NELSON: Were they ships of small tonnage?

Mr. ROSSETER: Six thousand. They operate very successfully.

Senator RANSDELL: Over what route?

Mr. ROSSETER: They operate from the Baltic, by way of Central American ports, to the Pacific coast, and back on the same route.

Senator RANSDELL: A good, long route?

Mr. ROSSETER: Yes.

The CHAIRMAN: Do you not think the Shipping Board could very well and very profitably experiment along lines of that kind?

Mr. ROSSETER: I had thought very strongly as to the importance of that. I must qualify my statement at this time by saying that everything now in my mind is contingent on the determination to go at this thing seriously, to face the problem as it is, and to construct our legislation in accordance with it. Failing to do that, we should not build and should get out the best way we know how.

The CHAIRMAN: Your idea is that we should go out and build up a proper American merchant marine or go out of business?

Mr. ROSSETER: That is right.

OUTPUT OF A CHINESE OIL ENGINE BUILDER

During the year ending December 31, 1919, the Hip Tong Wo Company, Canton, China, manufactured a total of 3,430 b.h.p. in marine heavy oil engines.

SMALL MOTOR SCHOONER FOR ANGLO-SAXON PETROLEUM CO.

The 332 tons gross auxiliary schooner "Melo" recently built in Holland has run her trials. She has been built for Royal Dutch-Shell interests by A. Paner of Alphen, and a Kromhout oil engine is installed.

NEW FUEL STATION AT SEATTLE

The new fuel oil terminal of the General Petroleum Co., at Seattle, Wash., can load oil into the bunkers of motorships at the rate of 430 tons an hour, so to fuel a 10,000 tons motorship for a 90 days' voyage will only take about two hours. The storage capacity of this station is 16,000 tons.

WOODEN MOTORSHIP COMPLETES VOYAGE AROUND THE WORLD

The full-powered wooden motorship "Challamba" recently arrived at Gloucester, Mass., from Irizo, Spain, with 3,000 tons of salt for the Gorton Pew Fisheries Company. She was but 16 days making the passage from Lisbon, and bad weather was encountered on all but three days. In reaching Gloucester the "Challamba" has practically completed a voyage around the world, having left the Pacific Coast with a cargo for Alexandria when she left the United States. From there, the ship proceeded through the Mediterranean to Iviza, Spain, where salt was loaded. She is propelled by twin McIntosh & Seymour Diesel engines.

AUSTRALIAN OIL BUSINESS

For some years America has done quite a good business with the supply of oils to Australia. The House of Representatives at Melbourne recently passed a bill by which the Anglo-Persian Oil Co. (Royal Dutch-Shell & British Government interest) will form a refining enterprise in conjunction with the Commonwealth Government. We suggest that a fleet of Diesel-driven tankers offers the only solution whereby American oil companies will be able to deliver refined oils cheaper to Australia than they can be produced locally. The public will buy the lowest priced oils regardless of origin.

PASSENGERS OF BIG MOTORSHIP LOAD CARGO

The new 13,200 ton d.w.c. Danish motorship "Afrika," which we illustrated on page 518 of our June issue, had an uncommon experience on her maiden voyage. She left Copenhagen for Christiania, says *Syren and Shipping*, and whilst in that port the Danish general strike began. The deckhands were called out on strike by telegram from Copenhagen, and left the ship. Much to their surprise the captain failed to worry. The Christiania cargo was all aboard, and the next thing the strikers knew, was that the ship left them—standing on the quay. The places of the missing men were taken by passengers, who rigged the 20 cargo booms on arrival in Stavanger in just 45 minutes.

When the Stavanger cargo was aboard, the ship cleared for Australia via Lisbon, everyone on board being utterly unconcerned as to whether or when the strike would end. This would indicate the simplicity of the electric winches, current for which is provided by Diesel-driven generators.

Diesel-Electric Drive for Merchant Ships

Comparisons Between Direct-Drive and Electric-Transmission

(Contributed)

AT the present time considerable investigations are being made into the question of electric-transmission in conjunction with Diesel oil-engines for the propulsion of merchant vessels, and of late the writer has been giving quite a little attention to the proposition, which is not without its good points. Possibly some data which has been accumulated will be of interest.

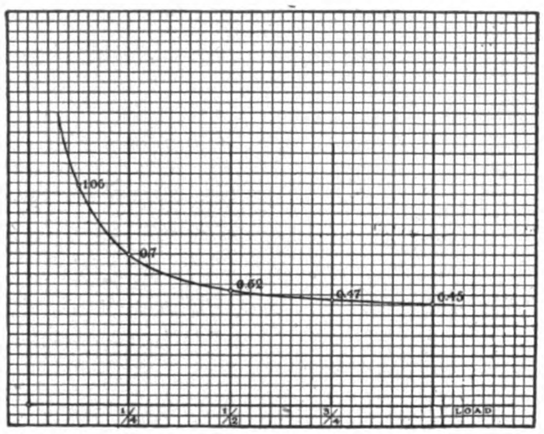
At first sight the Diesel-electric drive seems to be very attractive and much has been written and spoken about its simplicity of installation and operation. The electric ship-drive has been tried out on very large scale on certain big warships of our Navy, where space occupied and weight of the machinery is not of such great importance as in merchant ships, where space means cargo-carrying capacity and therefore revenue to the owner.

On warships the Turbo-electric drive has given in the few units so fitted out very satisfactory results and the biggest and most modern U. S. battleship, the "Tennessee," has her four propeller shafts driven by means of electric power generated in huge Turbo-electric generating sets, combining the most economical turbine speed with a suitable propeller speed.

But, in many instances things that are quite appropriate for warships do not necessarilly fit-in with vessels of the merchant type, and one of these is the electric-drive, no matter what means of power are used to generate the necessary electrical energy. However, as the Diesel-engine is today the most economical prime mover we know, it seems quite feasible to use this system of power for the production of the necessary electric-current to drive the propeller shafts by means of one or more electric motors.

At this stage we have in the steam-turbine a prime mover of unlimited capacity, whereas today, with the Diesel-engine we are limited in power because Diesel engines such as necessary to drive high-speed electric-generators, are only being built up to comparatively very moderate sizes, say, about 1,000 B.H.P. per engine at a speed of 225 to 250 R.P.M. Whereas slow-speed Diesel engines for direct connection to the propeller-shaft of 2,000 to 2,500 shaft H.P. running at 100 to 110 R. P. M. are available without any great difficulty here in this country as well as abroad.

The Diesel-electric drive may be of particular advantage in many special cases, as for instance, for trawlers, large tugboats or yachts, in which



Fuel-consumption curve (per b.h.p. hour) of standard high-speed Diesel engine for different loads at normal revolutions

craft a greater elasticity of propelled speed is required than on ordinary cargoboats. For such cases the Diesel-electric drive is nearly ideal, as the propeller-speed can be changed from zero to maximum speed without affecting the generating-sets, as they are regulated automatically by means of adequate governors in the same way as engines in stationary power-plants. For such moderate powers as required in the above-mentioned boats a very large range of available engines is on hand, and boats in service have given very good account of operation.

For larger cargo-boats say with 1,500 shaft H.P. and over, the question of getting suitable engines is more difficult. During the war only very light high-speed Diesel engines of the submarine-type have been built here and in Europe of a maximum capacity of 1,750-2,000 shaft H. P., and in one case of 3,000 B. H. P., German M. A. N. Engine, which, however, did not see actual war service in some boat, as the Armistice stopped all work on these larger U-boats in Germany just as the first ones were completed.

In the writer's opinion these particular engines are absolutely not suitable for any service at so high speed for regular merchant-marine work, as they would be put out of commission in a very short time. The maximum rotary speed of desirable engines of about 1,000 to 1,200 B. H. P. is around 220 to 250 R.P.M., as against 330-400 R. P. M. for submarine engines.

For a required propelling capacity in shaft H.P. it required with Diesel-electric drive a generating engine capacity of at least ten per cent higher than for direct-connection of the engines to the propeller shaft, in order to take care of the mechanical and electrical transmission losses in generators, electric-motors, and cables; for the necessary excitation in case that the exciters are to be driven directly from the engine crankshaft a still higher main-engine capacity is required. Generally, however, exciting-current will take from the separate auxiliary generating-sets, which always will be required for electric-light and for power for the winches when in port.

The attached table shows a comparison of Diesel-electric drive with direct Diesel-drive figured

Comparison Between Diesel-Electric and Direct-Diesel Drives

Cost and Weight

BASED UPON AVAILABLE ENGINES

(Contributed)

Propelling Apparatus	1,500 S. H. P.			2,500 S. H. P.		3,000 S. H. P.	
Type of Machinery	Elect. Drive	Elect. Drive	Direct Drive	Elect. Drive	Direct Drive	Elect. Drive	Direct Drive
No. of Diesel Engines	3	2	2	3	2	3	2
No. of Propellers	1	1	2	1	2	1	2
Total B.H.P. of Engines	1,680	1,680	1,500	2,800	2,500	3,360	3,000
Engine Speed R. P. M	250	225	135	225	120	210	105
Propeller Speed R. P. M	100	100	135	100	120	90	105
Cylinder Nos. and H. P. of 1 Engine	6 x 560	8 x 840	6 x 750	8 x 935	6 x 1,250	8 x 1,120	6 x 1,500
Weights in lbs.							
Engines	280,000	280,000	510,000	435,000	1,100,000	525,000	1,340,000
Generators	60,000	65,000	......	100,000	......	......	......
Motor	95,000	95,000	......	160,000	......	......	......
Control	3,500	3,500	......	5,800	......	......	......
Thrustblock	2,500	2,500	4,000	4,200	6,000	300,000	6,000
Propeller Shaftings	22,000	22,000	30,000	40,000	50,000	40,000	50,000
Main Engines, Total (Lbs.)	471,000	468,000	544,000	745,000	1,156,000	865,000	1,396,000
Aux. Generat. Sets (Lbs.)	60,000	60,000	60,000	90,000	90,000	90,000	90,000
Total Weight in Lbs	531,000	528,000	604,000	835,000	1,246,000	955,000	1,486,000
Weight per Shaft H. P	352-	351-	403-	334-	495-	319-	496-
Costs per Shaft H. P.							
Main Engines ($)	116-	113-	135-	112	125-	107	120
Elec. Equipment ($)	44-	44.-	......	34	......	34	......
Propeller Shafting ($)	4.4	4.4	4.5	4.5	4.5	4.5	4.5
Gener. Aux. Engines ($)	13-	13	13	12	12	10	10
Total per Shaft H. P. ($)	177.4	174.4-	152.5	162.5	141.5	155.5	134.5
Total Cost of Machinery ($)	267,000	263,000	230,000	405,000	355,000	465,000	405,000
Fuel Consumption							
Total B.H.P. Main Engines	1,680 B.H.P.	1,680 B. H. P.	1,500 S. H. P.	2,800 B. H. P.	2,500 S. H. P.	3,360 B. H. P.	3,000 S. H. P.
Total B.H.P. Aux. Engines	90 B.H.P.	90 B. H. P.	75 S. H. P.	150 B. H. P.	90 B. H. P.	210 B. H. P.	105 B. H. P.
Fuel Cons. per B. H. P, Main Engine	0.45 Lbs.	0.45 Lbs.	0.40 Lbs.	0.45 Lbs.	0.40 Lbs.	0.45 Lbs.	0.40 Lbs.
Fuel Cons. per B. H. P. Aux. Engine	0.45 Lbs.	0.45 Lbs.	0.45 Lbs.	0.45 Lbs.	0.45 Lbs.	0.45 Lbs.	0.45 Lbs.
Fuel per 1 Hr. Main Engs	755 Lbs.	755 Lbs.	600 Lbs.	1,260 Lbs.	1,000 Lbs.	1,510 Lbs.	1,200 Lbs.
Fuel per 1 Hr. Aux. Engs	40.5 Lbs.	40.5 Lbs.	35 Lbs.	67.5 Lbs.	40.5 Lbs.	94.5 Lbs.	47.25 Lbs.
Fuel per 1 Hr. Total Engs	795.5 Lbs.	795.5 Lbs.	635 Lbs.	1,327.5 Lbs.	1,040.5 Lbs.	1,604.5 Lbs.	1,247.25 Lbs.
Fuel Cons. per Shaft H. P. Hour	0.53 Lbs.	0.53 Lbs.	0.425 Lbs.	0.53 Lbs.	0.415 Lbs.	0.535 Lbs.	0.416 Lbs.
Fuel per Day (Tons)	8.77 Tons	8.7 Tons	7 Tons	14.5 Tons	11.4 Tons	17.5 Tons	13.6 Tons
Cruising Radius on 1,000 Tons Bunker Capacity (Navigation)	115 Days	115 Days	142.5 Days	69 Days	87.5 Days	57 Days	7.5 Days

out for 1,500 shaft H. P., 2,500 shaft H. P., and 3,000 shaft H. P. In each case separate electrically-driven engine-room auxiliaries as well as deck auxiliaries are presumed, the electric current being supplied by two or more separate generating sets of 50 K.W. and 62 K.W. It is further supposed that during navigation only one of such sets is in operation. For the Diesel-electric drive the necessary auxiliary power required is greater as with direct-drive on account of the exitation, of the dynamos and motors.

The comparison is based upon engines which are available today, and built here or abroad by manufacturers who were engaged during the war in the construction of submarine engines.

The prices indicated per shaft H. P. are approximate market prices as prevailing today. But it is quite within bounds that if the demand should warrant it, a special type of Diesel engine can be built to suit the requirements for Diesel-electric drive regarding the best economical speed and the occupied space, so to be able to favorably compete with the direct drive. It has to be borne in mind that in the most favorable circumstances the Diesel-electric drive will be less economical for the same shaft H.P. as direct drive, because high-speed engines themselves have a higher fuel-consumption than the slow-speed, direct-connected engine, and still more for the fact that the Diesel-electric drive requires a ten per cent higher engine capacity as the direct drive, because of the loss of power in transmission.

The weight and dimensions of the generating-engine set certainly can be reduced to some degree by the adoption of the solid-injection engine type, but also in this case the consumption will still be higher as we understand the guaranteed fuel consumption is around 0.48 lbs. B.H.P. which consumption reduced to actual shaft H.P. will be about 0.52 to 0.55 lbs. per H.P. hour as against 0.45 lbs. B.H.P. (shaft H.P.), for straight Diesel engines.

The datas on the direct-connected slow-speed engines are the standard figures which can be verified from quotations of any slow-speed Diesel engine builder in this country or abroad. The same applies to the figures given on the electric equipment.

Crankshafts and Cylinder Heads of Marine Diesel Engines.

By P. N. EVERETT, A.M.I.C.E.

(Of Sir Wm. Armstrong-Whitworth & Co., Ltd.)

The crankshaft is a most important part of the marine Diesel-engine. The failure of a crankshaft is so fatal that one is surprised that designers ever allow it to be even a possibility, and yet in the early days more than one engine failed in this item. Any crankshaft is, by reason of its geometrical form, a weak structure, and in a Diesel-engine any faulty setting or operating of the fuel-valve may cause very high loads to come upon it, so a good stiff crankshaft would save unnatural strains coming on the engine structure.

It is also necessary that a main-bearing be provided each side of each crank. The best proportion of engine makes it advisable to fit a solid-forged crankshaft if possible, and in a large engine this can be conveniently done by forging separately the crank for each pair of cylinders, and coupling them together. It should be carefully borne in mind that the material in the webs is not nearly so strong transversally, and due allowance made when fixing size of webs. A built-up crankshaft on standard marine lines is, however, cheaper and as the proportions will usually permit it there is no reason why this design should not be used.

Lloyd's rules give the generally accepted sizes for the crankshafts of marine Diesel-engines. These rules take into account both bending and twisting, and are based on a stress of 7,300 lbs. per square inch. But, it is not safe to depend on empirical rules for Diesel-engine crank-shaft design, and each engine should be considered by itself and a combined bending and twisting moment diagram drawn, which should include the air-compressors for H.P., high pressure and scavenge air, and of course be corrected for inertia forces, and should be checked for possible high loads when starting up. Such a diagram indicates where the high stresses occur.

As a rough approximation the diameter of the crankshaft for either a two or four cycle engine may be taken as ⅝ of the cylinder diameter irrespective of the number of cylinders or revolutions per minute. When it comes to the erection of the engine, the crankshaft is all important. It is most essential that the crankshaft be true and that its centre line is parallel with the top face of the bedplate so as to ensure the upper structure of the engine being erected normal to the crank-shaft.

The detail of the engine which has probably given greatest trouble in the past is the cylinder-head. In a four-cycle engine and also a two-cycle engine in which the scavenge-air enters from valves in the cylinder head, it takes considerable skill and experience in design to accommodate all the valves and passages in the space available if due consideration is given to speed of gases, and efficient water cooling. In all four-cycle engines there is at least one fuel-valve, one induction-valve, one exhaust-valve, and one air-starting valve, and generally in addition one safety-valve. The exhaust-passage must be water-jacketted and in the larger sizes the exhaust valve-cage and the valve itself will also be water-cooled; add to this the necessary bolts or studs for fixing the cover against pressure of 500 lbs. per square-inch, and the difficulties just mentioned will be easily appreciated.

When the design has been successfully evolved extreme care must be taken in the moulding, and also in the material chosen because the cylinder-head is a bounding side of the combustion-chamber, the temperature in which rises to 3,000 degrees Fahrenheit. Cast-iron was the metal used in the case of land engines, but when the marine-engineer took the matter up he immediately rushes to the idea that cast-steel was better, and this was a mistake as experience proved.

The unsuitability of cast-steel lies in its high co-efficient of contraction which produces high casting-stress, and to its high co-efficient of elasticity. Thus whilst cast-steel is two or three times as strong, yet the effect of heat is several times as great, consequently cast-steel is much more liable to fail than cast-iron when unequal expansion takes place. Failures occurred in way of the metal between the valve-cage ports where hair-cracks developed due to the variation in temperature, and these ultimately caused failure. Practically all this type of cylinder-head are now made of cast-iron; but the mixture must be suitable.

So far our remarks on cylinder-heads have referred to the four-cycle and valve-scavenge two-cycle types. Now an ideal cylinder-head would be one in which the metal is all of even thicknesses, and if any port holes are in, they should be centrally placed, then such a head could expand without danger, as it would go evenly in all directions and there would not be the slightest objection to its being made in cast-steel. The port-scavenge two-cycle engine permits of this design.

Ordinary cast-iron as known to the marine reciprocating steam-engine industry, of say seven to nine tons per square-inch tensile, has a worse feature than its low tensile strength. It grows to a disconcerting extent under the influence of repeated heating and cooling. This has been shown to be due to increase in volume, consequent upon the internal oxidization of various constituents by reason of the gradual penetration of oxidizing gases into the cast-iron and the presence of free graphite permits the entry and penetration of the gases. It is obvious then that the mixture must be of correct chemical composition, and even then casting temperature and the method of moulding are of equal importance; in fact such work takes years of experience with patient experimenting, in which the foundry-man, the metallurgist and the running engineer must all co-operate, and for a firm taking up the manufacture of Diesel engines the greatest caution should be exercised when arranging for the supply of castings.

RE: SULZER COMPARISON ARTICLE

Referring to the article on the Sulzer two-cycle engine and the propulsion of cargo-boats which appeared in our March and April issues, the illustration Fig. 9 on page 120 of the April number was given without the explanatory text, thus causing the illustration to lose most of its value, it not being possible to easily see which kind of ship the particular cut referred to. We, therefore, reprint the illustration together with the attached text on this page.

COMMERCIAL MOTOR VESSELS BUILDING FROM DESIGNS BY J. MURRAY WATTS

The following motor-craft are now under construction in various part of North and South America, from designs by J. Murray Watts of Philadelphia:

A shoal-draft passenger-boat and freighter for Mr. Charles Bardon, of Saigon, China. Both craft when completed will be fitted with heavy oil engines.

Smith & Williams of Maryland are now completing a 100 foot freight and passenger boat named "Atrato" in which two 180 h.p. Bolinder oil-engines are being installed. Her owner is Mr. F. A. Scharberg, of Cartegena, Columbia, and the vessel will shortly run under her own power to Cartegena.

Another craft for South America under construction at the same yard is the combination inspection and tow-boat "Periga," building to the order of the Maracaibo Oil Exploration Co., of Maracaibo, Venezuela. Two 37 b.h.p. Standard gasoline-engines are being installed.

Three motor tugs known as the Mary Louise," "Jimmy" and the Roberta" have been built for the U. S. Aluminum Co., and sent to Paramaribo, Dutch Guiana, South America. Two of them are fitted with a 100 h.p. Kahlenburg oil-engine, while the third is powered with a Standard gasoline-engine.

The three masted 150 foot auxiliary fishing schooner is to be built for Mr. E. W. Roberts, of Pelleys Island, by the Pelleys Island Shipbuilding Co., of Newfoundland. An oil-engine will be installed.

A 60 h. p. Gulowsen-Grei engine will be installed in the 65 foot steel fishing-boat designed for the Natchez Fish Company for use on the Mississippi River. She will be a stern-wheeler.

Now building at the yard of Continental Mexican Petroleum Company, Tampico, Mexico, is a 45 foot tug named the "Tampico." She is being powered with a Wolverine kerosene-engine.

A Wolverine engine and Galusha gas-producer set is to be installed in the 110 h.p. auxiliary schooner "Syra," owned by Antoine Barbetas, Shipbuilder, Syra, Greece.

Finally, there is a 65 foot shoal-draft freight and passenger boat now under construction at Flores, Guatemalteca, named the "Santa Clara," for the Compania Exportadora Guatemalteca of Flores.

SULZER DIESEL ENGINE FOR TANKER

The pair of 1,250 s.h.p. at 100 R.P.M. Sulzer two-cycle marine Diesel-engines, mentioned as now being built by Sir Armstrong, Whitworth & Co., under license are to be installed in a large oil-carrying tanker that is being built in the shipyard of the same firm.

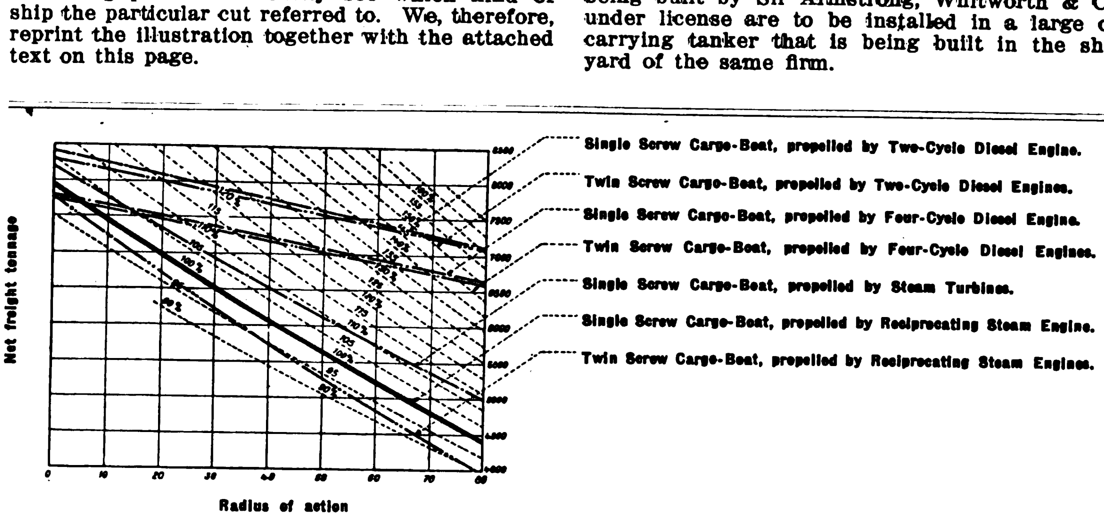


Fig. 9.—Variation of Cargo-Carrying Capacity with the Radius of Action (from 0 to 80 days) for Different Propelling Machinery, in a Ship of 12,500 Tons Displacement. (See page 12, April, 1920)

To Be or Not to Be?

A Straight-From-the-Shoulder Drive from an Experienced Seagoing Marine Engineer

By LIEUT. F. STEWART HAMMOND

LET us look over maritime conditions just as they are today, and determine from the enormous evidences before us whether the American Merchant Marine is—or not—to be seen on the seas two years hence. This vital question can only be answered by knowledge gained from observation and investigation, and from courage of conviction derived from observation of nearly ten years successful operation of foreign motorships now available to our ship owners, builders, and our Shipping Board. If they have insufficient evidence now, the answer is—NOT TO BE.

How so? For the simple reason that within two years every country, except the United States, will have its full quota of the most economical ships that can be put into the world's competitive marine business, while America will have not a ship (comparatively) to compete with Europe's great fleet of Diesel-driven motorships, and it will then be too late to begin building. As by then Europe will be fully equipped for competitive freight carrying and old strenuous competitive shipping conditions will then be the order of the day.

More normal conditions will prevail and low freight rates nearing those of pre-war conditions will not encourage the building of new American ships to compete with the economical motorships of Europe that will win business and dividends by good service. During which period our hastily constructed war-time ships will frequently be lying in port undergoing costly repairs and practically reconstruction.

A superintendent of one of our largest steamship companies recently told me that he was so busy looking over and auditing steamer repair bills and expense accounts that he did not have time to investigate the economy of the Diesel engine or listen to the arguments of the men who claimed so much for it. I would suggest that every big steamship company engage a competent efficiency man to advise them on the subject of the internal combustion oil engine and the economy and efficiency of the motorship.

Experiences of the past ten years ought to be sufficient for Americans to have seen and become convinced of the vast economy of the motorship. And it is my purpose in this effort to show how the shipping interests in the United States compare, and in what condition we are in in our effort to compete with Europe, and especially will be in at the end of the next two years.

But first let me define my position and offer, if deemed necessary, my apologies for "butting-in" on a subject great enough for professionals. I am a marine engineer of thirty years' experience with steamships. I have just returned from a four months' tour of Western Europe, where I have witnessed ninety per cent of the shipbuilding efforts.

When we realize that the first fully-powered motorship (Vulcanus") was built in 1910-11, but ten years ago—and during that ten years we went through a four years' world war which affected all shipbuilding material to an extent almost prohibitive to ship construction by private concerns and yet during that ten years European builders have built about one hundred and fifty large motorships and have as many more in different stages of constructtion or on order, I say,—if American shipowners could or would realize this marvelous development they would understand what is being done now that building material is at hand, and what the result must be two years hence. To emphasize this fact more strongly, attention is directed to the fact that one Danish firm and their licensees have built 54 fully-powered large motorships under unfavorable conditions and many of these practically during the last four years of the war—four years of difficulty. As they have orders for as many more one can easily understand what the result will be even in one year, when in Great Britain alone 24 old established shipyards are building merchant motorships.

The question now up to our shipowners is—TO BE or NOT TO BE in America! But, I am trying to drive home that with Europe it is a settled condition, for the fleet of motorships in commission and being rapidly completed, filling every yard to capacity and the order books of every Diesel engine builder filled to the point of refusing more, has been reached.

Do you grasp what that means and what the ultimate result must be at the end of several years? It means that unless our shipowners, shipbuilders, and Shipping Board have the courage and foresight to begin to build on a wide scale NOW, the answer is NOT TO BE, and I lament will NEVER BE for America.

The reception accorded me by the directors and other officials of the Burmeister & Wain Company induced me to remain in Copenhagen more than two weeks, visiting their yards and ships in all stages of completion and the great motorship "Afrika" on which I received a most cordial invitation to go on the trial trip. All readers of "Motorship" know of the power and magnificence of this new Diesel-propelled ship. If space would permit, I could tell you wonders about the main engines and the electric auxiliary equipment, also about the beautiful teak-wood saloon and quarters for twenty passengers. One of her striking features is the combining of passenger service and fast freight, making a class of ship that will, in my opinion, be adopted by all maritime nations in future.

Then there are other motorships in different stages of completion in their yards. They have orders from the East Asiatic Company for six sister motorships to the "Afrika," each of 18,600 tons displacement, six ships of 10,000 d.w.c. and six ships of 8,000 d.w.c. Besides they are building engines of their Diesel-type for some twelve other ships, whose hulls are being built in other yards, as their engine capacity is twice that of the ways now that their new machine-shops are completed.

I regret that I cannot elaborate on the completeness of these new shops and on some of the marvelous machines for special work of their own design and build, but there is one feature that must not be overlooked, it is their laboratory in which a chemical analysis is made of every metal that goes into the construction of the engine. This single feature alone is the means by which they have eliminated cylinder-head and liner troubles, as they assure me that they have not had the smallest trouble with either since they found just the metal for each part and now every metal used is exactly that which is required.

While in Copenhagen I visited eighteen (18) motorships that had just arrived from all parts of the world. Their troubles and cost of repair combined would not amount to the bill of the steamship on which I crossed the ocean—a fourteen days' sail.

I spent eight days in Kristiania, where I saw the engines and boilers taken out of two big steam freighters to be replaced with Diesel oil engines, and the yard blocked with new motorship construction all with Diesel propelling motors. Ten days in Göteborg revealed the same conditions or even greater activity in the building of motorships. Except for the three American ships in port, steamships in that part of the world seemed to be almost novelties. The same conditions in ship and engine building were found in Stockholm, where I put in eight days visiting the yards and shops. There has recently been established a very large Diesel-engine fuel-oil station, and at Sorn, a small port 15 miles down the Fjord from Kristiania, there is in a just completed state a large oil station to accommodate motor-shipping, but fuel oil is $90.00 per ton and coal is practically impossible to get.

In fact, the principal feature in all Scandinavia seems to be production, speed, and a drive at full capacity to obtain enormous production in the shortest possible time. So much so that every ship and engine builder in the Scandinavian States, Italy, Holland, and England are loaded to capacity and overstocked with orders. All Europe now recognizes the economy of the motorship and the great saving of fuel. The scarcity of coal forced their investigations and vividly impressed the value of oil engines in their minds. Is it any wonder that after a four years' Rip Van Winkle sleep of our Shipping Board that ex-Secretary Franklin K. Lane felt obliged to warn against this tremendous waste of the nation's oil-fuel in this country today?

At the end of two years from today, all European shipping countries will be in the field fully equipped with the most economic fleet of ships that the world can produce. Yet, Mr. Editor, a contemporary of yours says: **"The reason for the indifference of the U. S. Shipping Board toward the construction of motorships and the Diesel engine has never been satisfactorily explained."** Recently many men have called my attention to this same fact and there seems to be a mystery about the Diesel-engine development, especially with our Government. Is it possible, while knowing the great economic advantages of the Diesel engine that there is a great "Black Hand" in the executive government that is casting a blighting shadow, not only on the development but over every wise and able man that we have had at the head of our Shipping Board, who through much labor and effort have found that the Diesel engine is the only possible one for future ships? Or is it possible that the influence of our great steam-engine and boiler builders and bunker coal interests is enough to ruin forever our American Merchant Marine? We have only to read ex-Chairmen Denman's and Hurley's statements to convince ourselves.

However dark and disconsolate the case may be, there is always a ray of hope in some form: I move that all those in favor of the Diesel engine rise to a standing vote to present to Mr. Bernard Mills of the American-Hawaiian Line a gold medal appropriately struck. There is a man with courage of his convictions, there is a company of enterprising men. Hats off!

And following quickly on the heels of the American-Hawaiian Line are four other big companies of New York, who I understand have placed their orders with American builders for one or more Diesel-engined ships. I regret that I cannot give full details at this time. And yet another is standing up to be counted among the wise, this is the new up-to-date Sinclair Oil Company, who, while they are building six 10,000-ton d.w.c. tankers to meet a peculiar requirement are determined to build—as soon as their sphere of operation widens—a fleet of motorships. Mr. Johnson of this company has suggested to me that the Government could not do better than annually appropriate sufficient funds to instruct a large number of our marine engineers in the efficiency, erection, adjustment, and operation of the Diesel engine. For, as he put it, the reciprocating-engine is keyed up with a piece of lead wire and a sledge, while the Diesel requires a pair of feelers and micrometer, and instruction and practice is necessary to gain efficiency. The Sinclair Company already use many Diesel engines for their pipe lines.

In answer to a question put to one of our big ship companies, the superintendent engineer answered, "Yes, I am very strong for the Diesel engine, but if we could get the engines, where in h—— could we get the engineers to operate them?" Perhaps our one greatest handicap is the lack of competent Diesel engineers and our Government ought to consider this matter very seriously. Also shipowners must do their share of training men now. For, in my estimation, every geared-turbine ship must very soon be re-engined with the Diesel motor in order to survive.

I am just Yankee enough to believe that in this one case (that of the Diesel engine) we are slow to start—yet I'll bet my head that we will finish in the lead, and that the answer to the title of this letter will not be—NOT TO!—BUT, TO BE!

F. STEWART HAMMOND.

SMALL ITALIAN CONCRETE MOTOR VESSEL

The Societe Anonyme Navali Italiane Cemento Armato of Lavagna, has built the concrete motor vessel "Entella," 195 tons gross. A four-cylinder oil engine is installed.

NORWEGIAN CONCRETE MOTORSHIP

The 1,100 tons d.w. concrete motorship "Oddborg," owned by the Oddberg Motorship Company, was recently launched at the Mellby Schiolls Shipyard at Naersnes.

SMALL MOTOR VESSEL FOR STANDARD OIL COMPANY

The steel motor vessel "Delivery" was recently launched for the Standard Oil Company of New York from the yards of the Staten Island Shipbuilding Company. She is for the purpose of carrying bulk gasoline, her capacity for which is 90,000 gallons.

The Steinbecker Solid-Injection Engine

A New Design of Constant-Pressure Oil Motor, Built by the German Automobile Construction Company, Ltd., Berlin, and The Hanover Machine Co.

(Translated by W. Roylands Cooper.)

SINCE the introduction of the Diesel oil-engine the problem of the constant-pressure engine without compressor has been a very important one, and leading constructors in the field of marine and stationary oil-engine practice have worked towards its solution with varying results. Although for experienced engineers the building of the internal-combustion heavy oil engine has sometimes been a realm of unlimited disillusionment, nevertheless the solution of the problem above-mentioned is dependent entirely upon a knowledge of the newer scientific fundamentals and principles, and on designs based on these.

Elimination of high-pressure air, and the means for its production, storage and distribution (compressor, air-bottles, valves, air-pipes, and the starting-valve with its driving mechanism), is a primary condition for securing greater economy, reliability of running, a reduction in the need for supervision, and decreased first cost and maintenance, making possible the construction of high-speed, heavy-oil engines. The rise in price of the fuel-oils now being used, makes it necessary to use all cheap heavy-oils, *particularly those liquid-fuels which can be derived from the distillation of coal.* The possibility of an engine working on crude-oil or tar-oil carries with it a wide prospect.

Economical importance of such engines would consist in the reduction of cost by about 25 per cent in comparison with Diesel-engines already known.

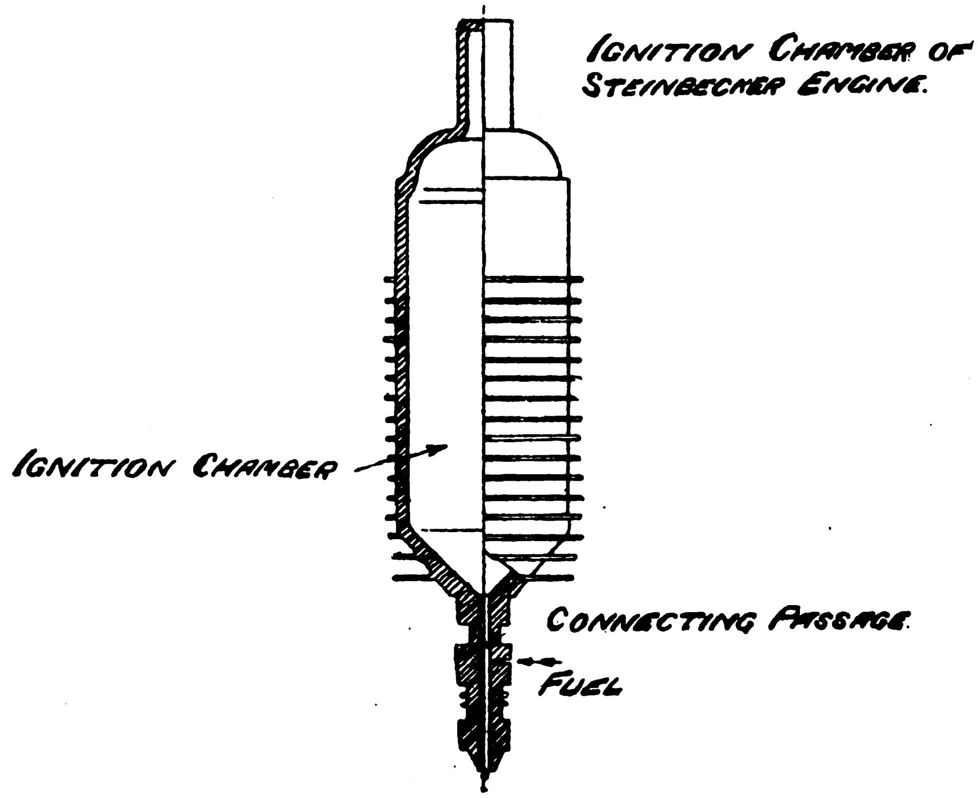
After a test period of seven years, it has now been possible, under the patents of Dipl.-Ing. Karl Steinbecker, of Berlin, Germany, to produce an internal-combustion engine without compressor. In the periodical *Oel und Gasmaschine* articles will appear from time to time dealing in detail with the test results and the use, for various purposes, of the "Steinbecker Engine."

After a period of seven years this engine has reached a certain stage of its development.

In the Steinbecker engine an ignition-chamber is by means of a connecting passage in constant communication with the cylinder space. On the compression-stroke of the piston a portion of the air compressed is forced-back into this ignition-chamber and is here stored up until the top dead-centre, the weight of such air being dependent on the dimensions of the connecting passage and the ignition-chamber. Into this air, moving with high velocity, a continuous stream of fuel is injected, about three degrees before the top dead-centre. The first particles of this stream are blown into the ignition-chamber, combustion taking place with the high-temperature air present in the chamber.

Resulting from this combustion and the constant increase of pressure, the direction of the air stream in the connecting passage is reversed, causing the still-entering stream of fuel to be atomized and blown into the working-cylinder, where the combustion takes place, with self-ignition, the combustion process being continued in accordance with the amount of fuel delivered.

Now, it is of fundamental importance for this process to arrange that the combustion in the ignition-chamber is of such a character that the pressure created is great enough to atomize the whole of the fuel delivered. For complete combustion a specific mixture of air and oil must be present. In order therefore to obtain a combustion fulfilling the above conditions, at the desired moment of ignition:



(1). Pure air, that is, air unmixed with exhaust gases, must be present in the ignition chamber.

(2). The fuel at the right moment and in the proper quantity must be delivered to mix with and ignite this air.

These simple and yet fundamental conditions are realized in the following manner: After every injection the fuel in the pipe stands, naturally, in close proximity with the connecting passage. This fuel is therefore exposed to the high temperatures and the very great variations of pressure which take place in the connecting passage, these varying from zero up to the full compression-pressure and suddenly increasing to the pressure of ignition in the ignition-chamber, falling again to zero when the chamber is emptied. Due to the easy compressibility of the oil, there is great danger of a very marked periodic change of pressure, particularly if the pipes, etc., are of an elastic nature.

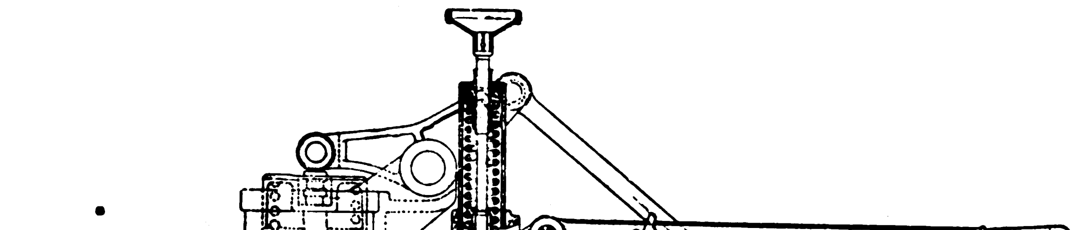
This oscillation of the fuel-column influences in a very harmful manner the mechanical control of the injection, allowing drops of oil to find their way into the connecting passage and ignition chamber. The effect of heat on the thread of oil is equally harmful and brings about considerable expansion, which in turn causes a dripping of the oil into the parts above-mentioned.

Loss of fuel from this cause is considerable, and it affects detrimentally the creating of the necessary pressure for atomization, as even the smallest drop of oil which finds its way prematurely into the ignition-chamber and is burned there, uses up a portion of the air charge and prevents, through increasing pressure and expansion in the chamber, which all the time is in contact with the combustion taking place, the further entry of the air charge.

In order therefore to obtain a mechanically controlled injection with the usual design of cam, the pressure-chamber of the pump must be of small capacity, with non-elastic walls and good cooling. Details of this pump are shown in the sketches illustrating the four-stroke engine.

There still, however, remains the undesirable condition that after every injection the fuel stands in close proximity with the connecting passage, in such a way that some particles of the column of fuel tend to be caught up by the hot gases and carried along with them. In order to completely eliminate this tendency, the fuel is, at the end of the injection period, drawn back a certain distance into the pipe. For this purpose a small piston of diameter equal to the valve-guide is fitted on to the delivery-valve behind the valve-seat.

On the pressure stroke of the pump, this piston is projected a short distance beyond the guide so that the fuel can flow round it. At the termination of the delivery stroke, or, rather, at the beginning of the suction-stroke, the piston is again drawn into the guide and draws with it fuel from the fuel-pipe, until the valve again reaches its seat.



Fuel-injection arrangements of Steinbecker oil-engine

From this point the suction-valve of the pump opens and the real suction-stroke is begun. This back suction is helped by the gas pressure which is transmitted from the connecting passage to the fuel in the pipe. As this back suction remains constant for all working conditions—its amount is determined once for all by the capacity of the small piston—the regulation of the fuel delivery is solely controlled by the cam.

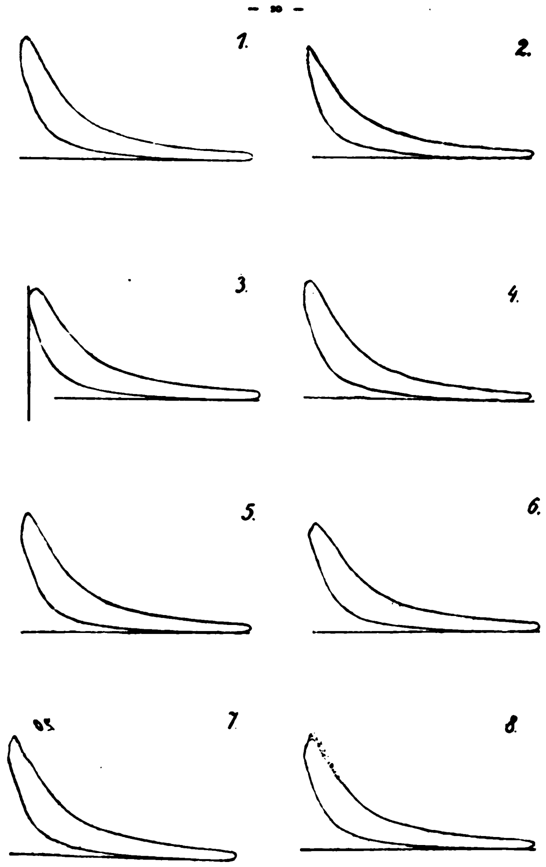
(2). *Mechanically-controlled Atomization.*

The atomization of the fuel, both as regards the ignition chamber and the cylinder, is brought about by designing the connecting passage with a double entry, the fuel being delivered in the middle of this smooth passage. During injection, the fine drops of oil entering the passage are caught up immediately by the moving gases, atomized and projected from either end of the passage according to the momentary direction of motion. When the fuel is in the connecting passage it cannot remain stationary or escape, because the narrowing of the stream, due to a drop of fuel, immediately releases pressure on this drop which acts in the direction of movement.

It will be seen that the necessary discharge or atomization energy is created by the fuel being forced through the passage. But, as atomizaztion commences the moment the fuel reaches the passage, the process of atomization both as regards quantity and time is solely effected by the cam form. This holds good for both directions of motion, as the connecting passage is double-ended.

The point where the movement is reversed, that is, the moment of ignition in the chamber and therefore the commencement of combustion in the cylinder, is equally mechanically-controlled. The fuel mixture swirls through the chamber and ignites only when it reaches the top part of the chamber, which is higher than the temperature of self-ignition. If the chamber is constructed of the right size and design, then the stored-up air is caught up in the swirling action and properly mixed with the fuel, causing adequate combustion to take place.

As mentioned at the outset, this combustion must always be of such strength as to fully atomize the maximum amount of fuel. This may be explained in the following words: High gas-pressure, which is brought about at the moment of combustion in the ignition chamber, falls off gradually as the gases escape through the con-



Indicator cards from Steinbecker engine

necting passage. The escaping gases must therefore be throttled in such a way that at the end of the injection there is enough pressure energy present for full atomization.

Throttling is brought about by the fuel itself, for, as soon as it enters the connecting passage, the escaping gases are called upon to perform work, and the process of ejection is correspondingly delayed. It follows from this that the ejection must from the beginning remain uninterrupted and take place in such a manner as to create this throttling action.

On the other hand, the law of delivery of fuel is prescribed by the combustion in the cylinder, according to the correct building-up of the diagram. These two conditions can only be fulfilled when the combustion in the ignition chamber is maintained of such a strength that its effect is not expended until the close of the injection period. Also, it follows that, when the energy of atomization is sufficient for the maximum amount of fuel, a good diagram can always be obtained for the lower loads. The excellent governing qualities of the engine down to the smallest possible injection is one of the best characteristics of the process.

The effect of the double-ended connecting passage above described is therefore fundamentally important for the mechanical control of the atomization process.

(3). *Mechanical Control of the Process Taking Place in the Ignition Chamber.*

It is of primary importance to remember that the ignition chamber, which is in the form of a pocket, is filled and emptied through the connecting passage. It must therefore be arranged that the fuel entering the ignition-chamber is fully burned and any surplus must again be ejected, as every particle of fuel which remains behind is drawn into the next working-cycle and there prematurely uses up a portion of the air charge.

Now, the walls of the ignition-chamber are the only part on to which the fuel can adhere. This must be prevented and prevention is made possible by maintaining the walls above a certain determined critical temperature, from which temperature downwards the fuel striking against the side is thrown off by means of the vapor it creates.

(To be Continued)

New Construction Notes

NEW FINNISH DIESEL ENGINE

A marine Diesel engine of the four-cycle type is now under construction at the works of the A. B. Andre & Rosenquest, of Finland. We understand that tests are now being run.

MOTORSHIP FOR ALFRED HOLT & CO.

An order for a pair of Diesel engines for a large merchant motorship has been placed with Harland & Wolff by Alfred Holt & Co., the well-known ship-owners of India Bldgs., Water Street, Liverpool, England. The hull will be built at another yard.

NEW MOTORSHIP "FINN" RUNS TRIALS

The steel motorship "Finn," 2,500 tons d.w.c., has just run trials at Stockholm, Sweden. She was built for the Sveabolag of that city at the Finnboda Shipyard, and is of the twin-screw shelter-deck class. Two 500 shaft h.p. Polar Diesel-engines are installed.

DIESEL TURBINES FOR SHIP PROPULSION

A 500 shaft h.p. internal-combustion turbine working on the Diesel cycle has been completed by the Société des Turbo-moteurs. A three-stage rotary air-compressor is used in conjunction with this engine. Water-cooled Vanadium and Tungsten steel blades are used. Thyssens of Mullheim, Germany, also are building an oil-turbine for a small ship. Before the war they completed a 1,000 h.p. gas-turbine for stationary purposes.

THREE MOTORSHIPS BUILDING IN RUSSIA

Although chaotic conditions are existing in Russia, and although we are unable to get our letters delivered, three twin-screw sets of Diesel-engines are under construction at the Kolomna Maschinenfabrik, Golutwin, near Moscow, for installation in three 750 tons d.w.c. motorships building at Reval for the Reval Steamship Co. The engines are of the four-cycle, four-cylinder type, with 12.99 inch diameter by 14.96 inch stroke at 300 R.P.M.

BELGIAN TUG WITH SULZER DIESEL ENGINES

Trials of the seagoing tug "Lucienne" have been run. She was built by the N. V. van der Kuy & van der Ree's Machinenfabrik & Scheepswerf, Rotterdam, Holland, to the order of Messrs. Hemelrijck of Antwerp, Belgium. She is 79 feet 2 inches long by 19 feet 8 inches breadth and is propelled by a 4-cylinder Sulzer two-cycle Diesel engine. The speed attained was 10.99 knots.

TRANSATLANTIC CO. BUYS MOTORSHIPS AND SELLS STEAMERS

Permission has been obtained by the Transatlantic S. S. Co. of Goteborg, Sweden, to sell 25,000 tons of its steamships abroad. The money thus made available will be used for their new Diesel-driven motorship fleet, three of which already are in service.

FIVE BIG MOTORSHIPS BUILDING AT THE ARDROSSAN SHIPYARD

In our issue of April (page 299) we referred to the Ardrossan Dry Dock and Shipbuilding Co., Ltd., of Ardrossan, Scotland, having received an order for three motor liners of 9,500 tons d.w.c. from Danish owners. These vessels will have Burmeister & Wain Diesel engines.

This shipyard also has received an order from the Otto & Thor Thoresen Line for two 7,500 tons d.w.c. motor-liners, in which Werkspoor Diesel-engines will be fitted. These two motorships will be run on the company's East African service.

MOTOR BARGES BUILDING IN INDIA FOR STANDARD OIL CO.

Two 100 h.p. motor oil-tank barges are building in India at the yard of John King & Co., Ltd., Howrah, for the Standard Oil Co. for offshore work at Coconada. The first has been launched.

TWO MORE BRITISH FIRMS ADOPT CAMMELL-LAIRD FULLAGAR DIESEL ENGINE

Elsewhere in this issue we refer to John Brown & Co. having taken a license to build Cammell-laird-Fullagar marine Diesel-engines in high powers for liners. Our British contemporary, "Syren and Shipping," mentions that David Rowan & Co., of Glasgow, and Dunsmuir & Jackson of Govan, Scotland, also have secured licenses for this design of opposed-piston oil-engine. Both these firms are steam-engine builders.

MOTORSHIPS "MAGVANA" and "MELMA"

Two of the five motorships for the British India Steam Navigation Co. are being built by Barclay Curle & Co., of Glasgow, and are being four-cycle Diesel-engined by the North British Diesel Engine Works. They have been named "Magvana" and "Melma" respectively, are of 9,000 gross tons and will carry 100 first-class passengers and 50 second-class passengers. Their speed will be 13 knots on a fuel consumption of 15 tons of oil per day. Robert Duncan & Co. are building a motorship for this Line, as are Alex. Stephen & Sons, Linthouse, only the latter vessel will have Sulzer two-cycle Diesel engines as mentioned on another page in this issue. For further details see the November, 1919, issue of "Motorship."

NEW MOTORSHIPS FOR BIBBY LINE BUILDING BY HARLAND & WOLFF

	Gross Tonnage	Approx. D.W.C. Tonnage	Power
"Dorsetshire"	9,200	10,500	4,500 I.H.P.
"Somersetshire" ...	9,200	10,500	4,500 I.H.P.
"Yorkshire"	10,500	16,500	6,600 I.H.P.

HIGH SPEED DIESEL ENGINE RUNS A 168 HOUR CONTINUOUS TEST

A test of 168 continuous hours without a stop has been run by a 300 brake h.p. North British Diesel-engine, built for engine-room auxiliary purposes in one of the motorships now under construction for the British India Steam Navigation Company. The fuel-consumption was 0.455 lbs. per b.h.p. hour of Anglo-Persian fuel-oil. This is very excellent for a high-speed marine oil-engine.

MESSRS. SULZER-FRERES REPLY

Just as we are closing for press we received a reply from Messrs. Sulzer-Freres to the letter by Mr. Shaw on the four-cycle versus two-cycle controversy. Messrs. Sulzer-Freres letter will be published in our August issue.

A FRANK OPINION

The intermediate stage of the oil-burning steamship holds sway at present; but in view of the greatly superior fuel economy of the motor ship, the use of oil under boilers can only be looked upon as wasteful when once a thoroughly reliable oil engine is assured. Judging from the large number of motorships now building, that time seems to be rapidly approaching, if it has not yet already come.—"The Shipbuilder," (England).

Air-Injection for High-Pressure Oil-Engines

A Valuable Technical Article of Particular Interest to Diesel Marine-Engine Designers and Builders

By J. L. CHALONER

INTEREST for a considerable time has centered around the best methods for an effective and efficient atomization is undoubtedly due to the importance which the pulverization of the fuel bears in relation to the general running and flexibility, in the sense of using fuels of as wide a range, as commercially possible, of any medium or high-pressure oil-engine.

Owing to economic conditions the tendency is to use or attempt to use a fuel inferior to that hitherto considered as the standard grade for

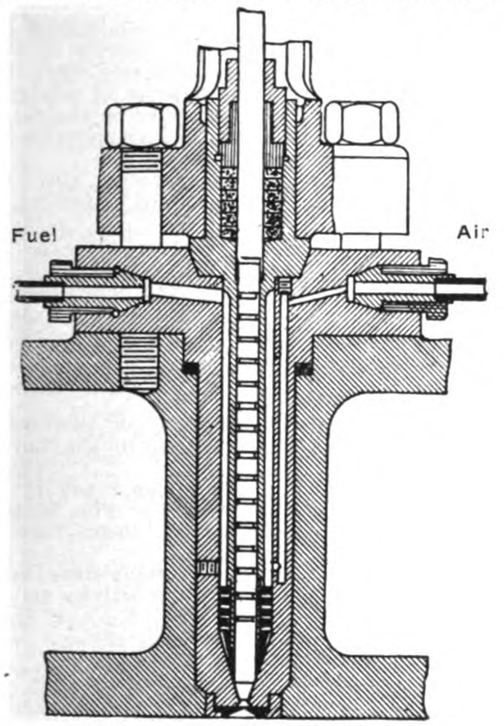


Fig. 1

this or that particular type of engine. Inferior fuels mean more economical results, provided those conditions are possible under which such low-grade fuels can be burnt satisfactorily.

It may be considered more or less general practice amongst shipowners to convert existing vessels from coal-fired systems to oil-fired installation, and fit out their new tonnage with Diesel oil-engines.

When it is pointed-out to the owner of such a mixed fleet, that he may have to provide for contracts covering two grades of fuel, he is brought face to face with one of the limitations of the oil-engine, inasmuch as the oil-engine in the hands of the average engineer is not yet able to burn the same grade of oil and with the same degree of reliability as the fuel-oil burner under boilers.

The arrangement for filtering oil-engine fuels, the maximum permissible percentage of ash, mechanical impurities, or other incombustible matter, are points which require the attention of the department responsible for the drafting of the specification for fuels suitable for marine oil-engine installations.

The engine-builder is quite aware of this apparent lack of flexibility on part of the engine, and the many varied patent atomizers, pulverizers and such like are purely the outcome of the many efforts by designers to find a solution to the problem of efficacious atomization.

It is admitted at once that combustion is not a difficult process to produce, but when such a process has to be carried out under unfavorable conditions and in the shortest time, one meets obstacles which are not readily overcome. There are a certain number of preparatory conditions which are essential for leading-up to that gaseous state of the charge which will produce a high degree of combustion. Furthermore, there is an obvious reason that the oil in passing from the liquid form into a homogeneous gaseous mixture should reach the various stages in a definite sequence. Pulverization, vaporization, mixing of fuel with combustion-air, dissociation, and finally combustion is the correct sequence as advocated by experts, and any new inventions which deviate appreciably from this order are doomed.

Considering now the broad principles underlying the numerous attempts to produce effective results, we have:

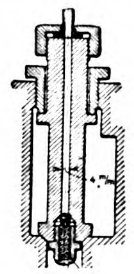
1. *Air-injection.*
   The fuel is injected into the combustion chamber proper or an uncooled extension of the chamber by means of highly-compressed air.
2. *Mechanical-injection.*
   The fuel is injected into the combustion-chamber proper or an uncooled extension of same under a high pressure, but without air.
3. *"Gas-pressure" injection.*
   The fuel is injected into a passage connecting the combustion-chamber with an uncooled extension. During the injection period a portion of the fuel enters the extension, rapidly vaporizes, and the resulting gas pressure forces the remainder of the fuel into the combustion-chamber proper.

Of the above mentioned three methods it can be stated that the first system is the conventional method for the high-pressure Diesel-type oil-engine. The second method has been in use for the surface-ignition type or medium pressure oil-engine, whereas the last principle has so far found very little application in commercial designs.

In this connection it is rather interesting to note that whereas with the high-pressure engine attempts have been made to use mechanical injection, to avoid the rather cumbersome air-compressor, the latest designs for the surface-ignition engine have introduced air-injection for some reason or other. Again the more timid type of designer, afraid of making a *faux pas*, yet anxious to benefit by any possible improvements which any one of the above principles may possess, has attempted to retain the compressed-air, but using it principally as a pressure agent, irrespective of any features it may or may not have as an atomizing agent.

Again the question where and when the compressed-air stream should meet the fuel-globules in the fuel-valve casing is full of controversial opinions, shown by the many patents dealing with this matter. Some of the suggestions put forward are obviously wrong and only help to emphasize the fact that there is considerable doubt on part the designer as to how the maximum effect in the way of atomization can be produced. Such an unsatisfactory state of affairs is largely due to the distinct lack of data in connection with the injection principle generally and that of air-injection in particular, with the result that the original design of pulverizer washers and fluted cone has held its own up to the present.

It is not intended in this article to examine the relative advantages of air and mechanical injection, but it is proposed to analyze the air-injection principle and collect all such data as are available on the subject. The relative merits and demerits of air and mechanical injection will presently be subjected to the most scrutinous investigations, and it is therefore essential that we should be in possession of all such data as will



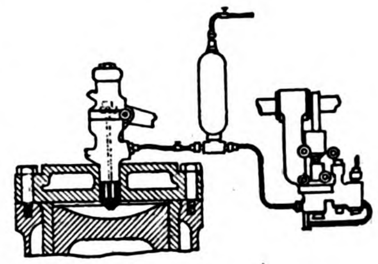


Fig. 2 Fig. 3

help to arrive at the correct deductions on a matter which will play an important part in the further successful progress of the oil-engine.

In Fig. 1 an example of air-injection of the standard type is shown. Fig. 2 shows a fuel-valve for surface-ignition engines, of the vertical type. Fig. 3 gives a view of a mechanical injection as used with high-pressure oil-engines, whereas the illustration in Fig. 4 shows the general principle on which the horizontal type of surface ignition engine is operated. Fig. 5 shows a sectional view of an engine working on the "gas-pressure" injection, there being shown sufficient of the details to make any further description unnecessary.

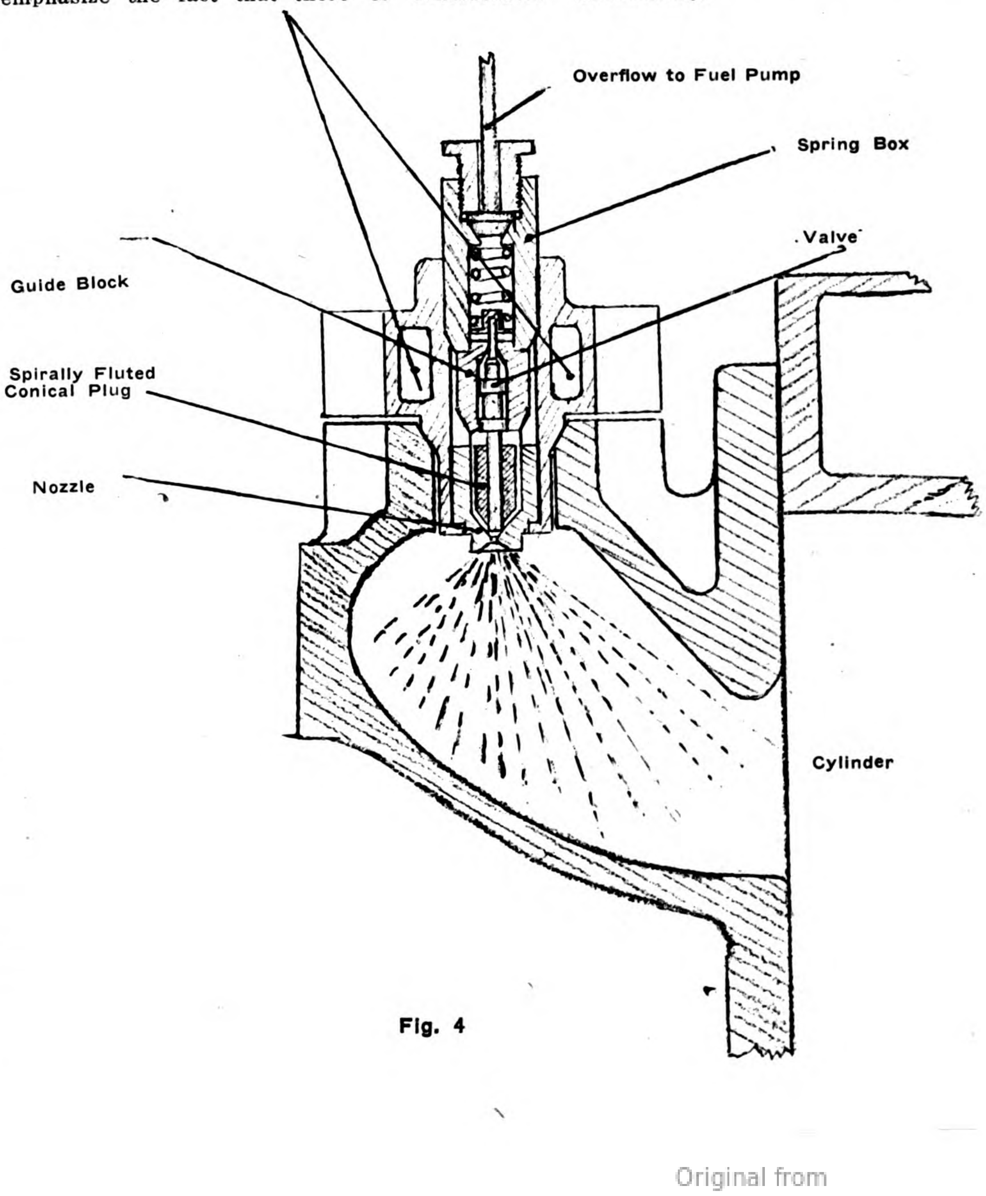


Fig. 4

In dealing then with the question of air-injection, it is proposed to examine three of the leading factors, namely:

(1). The design and construction of the fuel-valve.

(2). Compressed-air as an atomizer.

(3). The relation between injection-air and the degree of combustion.

(1). *High-pressure oil-engine fuel-valves.*

The various cross-sectional areas of the fuel-valve casing and the fuel-valve proper bear an important relation to the velocity which is given to the air-oil mixture as it enters the combustion chamber. It has been recognized for a considerable time now that the so-called pulverizer washers do not assist in the atomization of the fuel, but purely act as distributors of the oil particles in the air current. At the same time it is admitted that these washers, together with a correct proportioning of the size of the staggered holes in the washers, the profile and opening period of the fuel valve cam, and finally the size of the flame plate orifice, all help towards the final object, *i.e.*, a maximum degree of efficient atomization.

It can be shown that the mere altering of the fuel-cam profile has very little influence, unless it is accompanied by a corresponding alteration of the fuel-valve opening period.

As is well-known there is a continously varying set of conditions depending on the load carried by the engine, and it is the general impression that at light loads the injection period should be reduced, in order to allow a smaller amount of air to enter the cylinder, thus minimizing the cooling effect of the air. For stationary work the reduction of the pressure relative to the load meets the case in a satisfactory and more or less practical manner. For marine work, however, where the speed is the governing variable, the conditions are somewhat different, and require a more careful analysis of the relative velocities of the air, the oil, and the engine piston.

Again the opening period of the fuel-valve is governed by the relatively rapid drop of pressure after the major portion of the fuel has been burnt. An examination of an indicator diagram will show, that at 30 degrees past the top centre the pressure is probably 480 lbs. per square inch, whereas at 40 degrees past the top dead-centre it is quite as low as 330 lbs. per square inch. Assuming an injection-pressure of 900 lbs. per square inch, it will be noted that between 10 degrees, there is a change in the pressure difference from 420 lbs. to 570 lbs. Larger amounts and greater expansion of the injection-air tend towards increased cooling effect at comparatively constant combustion-temperature, thereby increasing the fuel-consumption.

The cooling of the combustion zone by the compressed-air is fully realized by all designers, and some ingenious details of construction have been devised to overcome this defect. Fig. No. 6 shows such a design having this object in view. Attention is drawn to the pilot-ignition system for burning tar-oil, where the pilot ignition-oil is pumped into an annular space as closely as possible arranged near the fuel-valve seating, in order to ensure that with the opening of the fuel-valve, oil will enter the combustion zone, and not either air or oil and air.

Fig. No. 7 indicates this system, the sectional view showing the passages for the main and pilot charge. How this cooling effect makes itself felt on the indicator diagrams becomes apparent from the accompanying illustrations. Figs. 8, 9 and 10 show full-load, half-load and no-load diagrams respectively for an engine working on the ordinary method. Figs. 11, 12, 13 and 14 are cards for full-load, three-quarter load, half load, and no-load respectively for an engine using the same grade of fuel—which by the way was a petroleum residue—but passing a portion through the pilot pump, thereby ensuring that on the fuel-valve opening a drop of oil would enter the cylinder. The diagrams explain themselves and require no further comments.

It is suggested that as the viscosity of the fuel increases, the effect of cooling becomes more pronounced. Higher viscosity generally means cheaper grade, does not burn as readily, or in other words requires more heat for complete combustion. The fact that this larger supply of heat must be applied in the same space of time, makes it essential that the cooling effect from any source whatever must be an absolute minimum. On the other hand, a higher viscosity brings with it a greater pulverizing force to break it up into the desirable fineness, and it can therefore be readily understood that there is a fixed limit of the grade of oil which can be burnt satisfactorily in a high-pressure oil-engine, using air-injection as the atomizing agent.

The fact that the injection period represents only 14 per cent of the complete stroke, as against nearly 75 per cent for the inlet and exhaust period, would indicate the comparative sensitiveness of any adjustment regarding opening period or lift of the fuel-valve. Even the warming up of the engine has an appreciable effect on the adjustment, because owing to the expansion generally, the roller clearances alter with rising temperatures. The following table will make this point clear; the clearances referring to a four-stroke exhaust-valve for a six-cylinder engine:

TABLE No. 1

LINE No.		I	II	III	IV	V	VI
Roller	Cold	0.037 in.	0.037 in.	0.037 in.	0.037 in.	0.037 in.	0.037 in.
Clearance	Warm	0.016 in.	0.026 in.	0.018 in.	0.016 in.	0.014 in.	0.028 in.
Difference		0.021 in.	0.011 in.	0.019 in.	0.021 in.	0.023 in.	0.009 in.

It should be stated that with the fuel-valve the difference between the cold and warm condition of the engine is not quite so marked, but at the same time it is a factor not to be lost sight of in the testing of an engine.

Attempts have been made to standardize the proportions of the essential details of the fuel-valve, it being suggested to use the flame plate orifice in one case and the fuel-valve diameter in another as the unit.

For the former proposal, the following relation has been established:

$$d \ \tfrac{1}{3}\, k. \ \sqrt{N} \quad \ldots\ldots \quad \text{I}$$

where

d is the diameter of the flame-plate orifice,

k is a constant depending on fuel-valve diameter, interior di ameter of fuel-valve casing, size and pitch of pulverizer washers, the frictional resistance created at the different cross-sectional areas in the oil and air passages, and finally the viscosity of the fuel.

N is the I.H.P. for the engine under discussion. (per cylinder)

Unfortunately no values for the constant k are suggested, so that the formula is hardly of that practical utility as might be desirable. Fig. 15a shows curves for the various parts of the fuel-valves in multiples of the diameter of the flame-plate orifice. The data are only applicable to four-stroke engines.

Another formula has been suggested, the fuel-valve diameter being used this time, as follows:

$$D^2 = k. N \quad \ldots\ldots \quad \text{II}$$

where

D is the diameter of the fuel-valve needle,

k is a constant, being equivalent to
0.005 for four-stroke engines
0.00232 for two-stroke engines.

N is the I.H.P developed per cylinder in the engine.

Fig. 15b shows the two curves for two-stroke and four-stroke units in relation to the horse-power developed per cylinder.

It is suggested that the formulas I and II together with the curve illustrated in Fig. 15 will enable designers to standardize their various units.

During the last few years, designs have been introduced recommending two fuel-valves driven off the same came lever. Such a construction necessitates the lift of the two valves being different and to counteract a possible uneven distribution of the fuel, the cross-sectional area of the two valves is proportioned accordingly. The introduction of multiple valves may be for two reasons; either it tends towards a more uniform distribution of the charge over the combustion space, or that with a smaller amount of fuel a better degree of atomization is attainable. It is suggested that the former is of primary consequence, and must have proved very effective in view of the fact that two fuel-valves hardly lead to simplicity of the cylinder head. (Fig. 16.)

(*To be continued*)

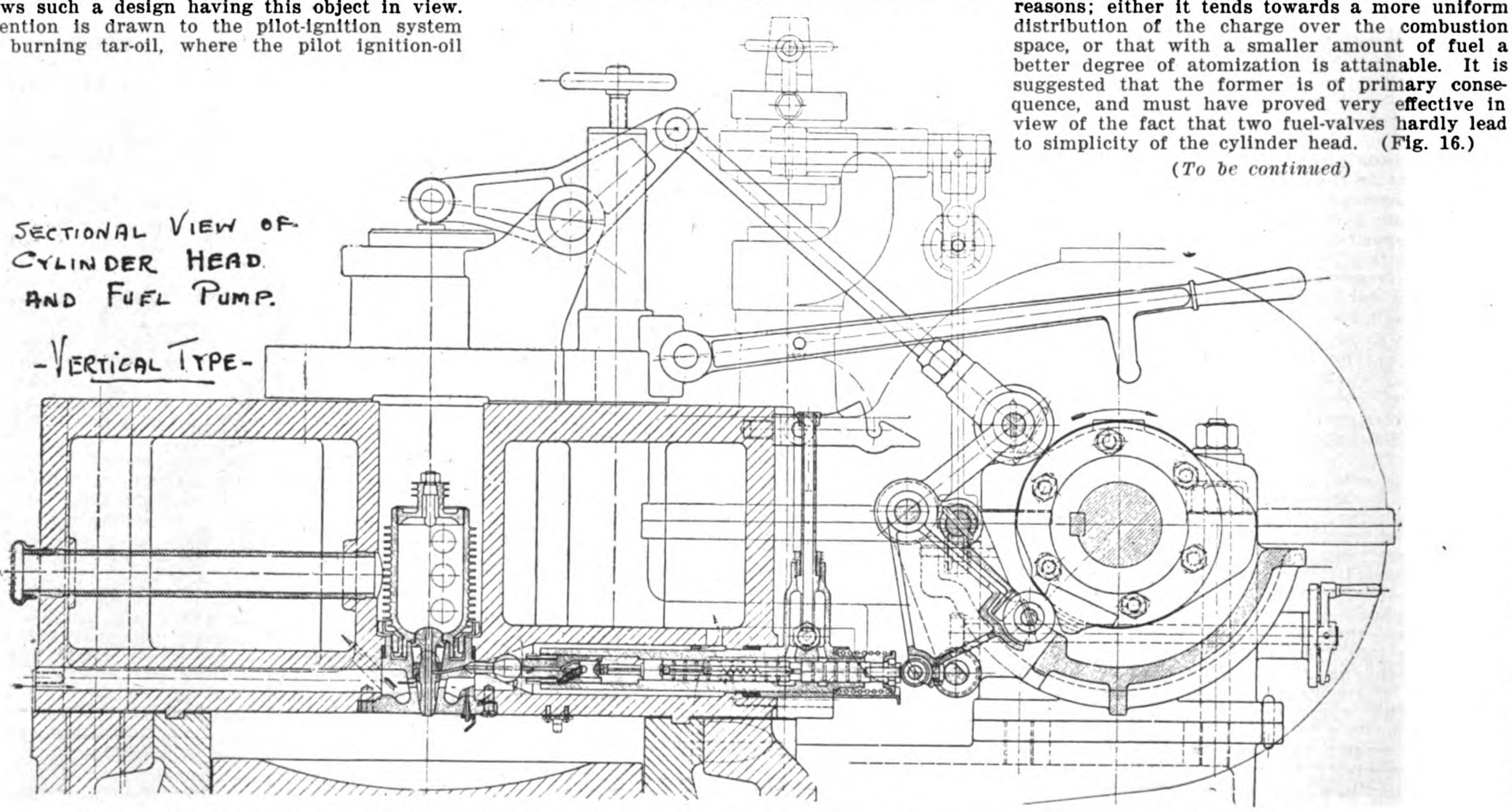


Fig. 5. Sectional view of Steinbecker cylinder-head and fuel-pump. Another drawing is given elsewhere in this issue

Interesting Notes and News From Everywhere

MOTORSHIP SERVICE FROM HAMBURG TO JAVA

The veteran Danish motorship "Selandia" recently inaugurated the resumption of cargo-ship services between Germany and Java.

BULLETIN ON EXPANSION JOINTS

A very interesting bulletin has just been issued by the Griscom-Russell Company dealing with their expansion joint. Copies of this bulletin can be obtained from their office at 90 West Street, New York City.

TWENTY-TWO AMERICAN MOTORSHIPS WITH McINTOSH & SEYMOUR DIESEL ENGINES

To give an idea of the extent to which the American merchant motorship marine is growing we will mention that there are now in service 22 motorships aggregating 74,300 d.w. tons, propelled by McIntosh & Seymour Diesel egnines.

FRENCH GOVERNMENT'S NEW MOTOR FISHING FLEET

With reference to the large appropriation of the French Department of Sea Fisheries, details of which were given in "Motorship" several months ago, we learn that the department has ordered 40 motor vessels of 250 tons and 100 h.p., and 110 motor vessels of 50 tons each. All are auxiliary craft. At the time we suggested that American engine builders should get after this business.

ANOTHER DIESEL ENGINE TREATISE

A paper on marine and Diesel oil engines will be read very shortly before the Northeast Coast Institution of engineers and shipbuilders at Newcastle-on-Tyne, by Mr. K. O. Keller, Technical Director of Wm. Doxford & Sons, Sunderland, England.

MOTORSHIP LAUNCHED FOR PACIFIC STEAM NAVIGATION COMPANY

On May 6 the 6,800 tons gross motorship "La Paz" was launched by Harland & Wolff, of Glasgow, for the Pacific Steam Navigation Company. She is propelled by two sets of Burmeister & Wain type Diesel-engines built by Harland & Wolff. The vessel is 420 ft. long (b.p.), 54 ft. breadth and 27 ft. draught.

FIVE MOTORSHIPS FOR THE BRITISH INDIA STEAM NAVIGATION CO.

In "Motorship" for November, 1919, an exclusive announcement was given to the effect that the British Steam Navigation Co. and their associated company, the Union Steamship Co., of New Zealand, had ordered four large North-British four-cycle Diesel-driven motorships. The first mentioned company has ordered another 11,000 tons d.w.c. motorship, this time from Alexander Stephen & Son, Linthouse, Glasgow. Two 1,600 shaft h.p. Stephen-Sulzer two-cycle Diesel-engines will be installed.

THREE MOTORSHIPS FOR ROYAL MAIL STEAM PACKET COMPANY

In a recent issue we referred to some motorships under construction in England for the Royal Mail Steam Packet Company. An order for three motorships of 8,000 tons each has been placed by this well-known British steamship company with Workman, Clark & Co., Ltd., of Belfast, for the River Plate service. Burmeister & Wain type Diesel-engines will be installed and the same will be constructed by Harland & Wolff, Ltd. This now makes 25 British firms engaged in the construction of motorships, as Workman Clark were not included in the list published in our editorial of May, 1920.

JAPANESE FIRM TO BUILD MIDWEST DIESEL ENGINES

A deal covering the drawings and license to build Midwest marine and stationary Diesel-engines in Japan is now being consummated by Mr. R. A. Brett, 192 Broadway, New York City, with Mr. Tatsuzo Kosugi, of Kobe. The transaction also covers the sale of a 100 s.h.p. Midwest marine Diesel engine, which will be used for testing and demonstration purposes.

It will be recalled that Mr. Kosugi recently completed an extensive tour throughout the United States and Europe, having made an exhaustive study of various Diesel-engines and their manufacturing conditions. It is believed that Mr. Kosugi is acting on behalf of the Osaka Iron Works of Osaka, Japan, as he is financially interested in this progressive Japanese shipyard.

JOHN BROWN & CO. TO BUILD CAMMEL-LAIRD-FULLAGAR MARINE DIESEL ENGINES

A license to construct Cammellaird-Fullagar opposed-piston type marine Diesel-engines has been secured by John Brown & Co., Clydebank, Glasgow, Scotland. They will build these motorship, two-cycle oil-engines in high powers.

MOTORSHIPS AT MANITOWOC SHIPYARD

There is no truth in the report published in other publications that the Manitowoc Shipbuilding Company will build five 3,300 ton d.w. freighters for their own use, or that these vessels will be motor-driven. Their first small marine Diesel-engine is in process of erection and they are now commencing the pattern work for their first large engine.

DIESEL FUEL OIL AT $3.50 PER BARREL

According to a recent issue of the "Panama Canal Record" three companies with tanks at Balboa have advanced their price of Diesel fuel oil to $3.50 per 42 gallon barrel. The average sales to motorships are 10,000 barrels per month, compared with 214,270 barrels of oil sold to oil-wasting steamships. A new Diesel fuel station is being erected at Cristobal.

LAUNCH OF LARGE TOSI-ENGINED MOTORSHIP

An 8,000 ton motorship named "Alfiere" has been launched at Messrs. Franco Tosi's Taranto shipyard, and we understand that she will shortly be placed in service. Two 1,200 h.p. Tosi six-cylinder, four-cycle, cross-head type, Diesel-engines are installed, together with complete Diesel-electric auxiliaries, all the latter having been manufactured by the same firm.

ANCHOR BROCKLEBANK LINE'S MOTORSHIP TO BE NAMED "MILIA"

"Milia" is the name of the 5,000 tons motorship now being constructed for the Anchor Brocklebank Line at the yard of W. Hamilton & Co., on the Clyde, in which two 4-cylinder 1,000 B.H.P. Cammell-Laird Fullagar opposed-piston, two-cycle type Diesel engines are to be installed. The name of the Anchor Brocklebank's small motor-vessel is, of course, the "Fullagar." She is already in service and was illustrated in a recent issue of "Motorship."

SIX 14,000 TONS D.W.C. MOTORSHIPS NOW ON ORDER FOR THE GLEN LINE

In addition to the motorship "Glenogle" and three sister 14,000 tons d.w.c. Diesel-driven ships now on order for the Glen Line, we understand that these well-known British shipowners have placed orders for two additional 14,000 ton motorships with Harland & Wolff. This is in addition to the fleet of smaller motorships also on order. The Glen Line has nine motorships in service including the "Glenapp," which is a little smaller than the "Glenogle." When the vessels on order are completed, the Glen Line will have one of the largest motorship fleets in service.

MORRIS WHITAKER JOINS TAMS, LEMOINE AND CRANE

Morris M. Whitaker, Naval Architect, has joined forces with Tams, Lemoine & Crane, of 52 Pine Street, New York, and will have active charge of the designing and supervision of the construction of the commercial and cargo ship department, as well as their yacht work.

Mr. Whitaker is one of the best known American naval architects and comes from a family which has followed the sea for generations, his father having been a chief engineer in the United States Navy, serving through the Civil War and up to 1895. Mr. Whitaker graduated from Yale and started his professional career with the Newport News Shipbuilding and Dry Dock Company.

By training, education and natural ability Mr. Whitaker is undoubtedly a very capable and efficient naval architect and Tams, Lemoine & Crane are to be congratulated on adding him to their organization and he will undoubtedly strengthen and broaden the scope of work characteristic of this well-known and old established concern.

At the present time Tams, Lemoine & Crane are doing considerable work for South American and Australasian clients, including a tug for British Guiana; a small shallow-draft Diesel-driven cargo-vessel and several barges for South American use. Within the last few months a number of 1,800 tons Winton Diesel-driven auxiliary schooners were completed from their plans for the American Car and Foundry Company.

WINDLASS CATALOGUE

We have just received copy of a new catalogue that has just been issued by the American Engineering Co. of Philadelphia, dealing with their various designs of steam and hand-powered windlass. Letters from responsible parties addressed care of Mr. D. C. Spencer will produce a copy promptly.

ZEPPELIN WORKS BUILD OIL-ENGINED CRAFT

The first of a series of 50 foot fishing boats has just been completed to the order of the German Government at the Friedrichshafen, Zeppelin Works, Warnemunde. A 25 b.h.p. Callesen surface ignition oil engine is installed.

NEW MOTORSHIP FOR HAMBURG-AMERICAN LINE

Blohm & Voss, the well-known Hamburg shipbuilders who constructed the double-acting Diesel engines of the motorship "Fritz," are building a pair of 1,350 shaft h.p. Diesel-engines for a twin-screw cargo motorship for the Hamburg-American Line.

PACIFIC COAST SHIPBUILDERS GO TO EUROPE FOR DIESEL LICENSES

Mr. George A. Armes and Robert S. Moore, President and Vice-President, respectively, of the Moore Shipbuilding Co., left New York June 19th for Hamburg aboard the liner "Manchuria" for the purpose of negotiating with European firms, with a view to obtaining a marine Diesel-engine license. Just prior to leaving the Pacific Coast Mr. Armes advised the *San Francisco Chronicle* that there is no question about the future of the internal-combustion engine. He added it is his belief in a few years there will be little or no steamship construction, and every shipbuilding concern in this country will be devoting every activity toward the construction of motorships.

Mr. Armes pointed out that in the interests of economy the marine of the world, at least that part that is depended upon to carry the freights, will have to utilize the more economical engine and the steam-boiler will go into the scrap-heap. If all of our freighters were motorships, only 30 to 35 per cent of the present amount of fuel being consumed would be needed for this purpose. The immediate result would be a lessened demand for petroleum and the price would go down.

THOR THORESEN'S VIEWS ON MOTORSHIPS AND AMERICAN SHIPPING

Since the armistice the Norwegian shipping firm of Otto and Thor Thoresen A. S. of Christiania have ordered twenty-three vessels aggregating 85,000 tons, d.w.c. including many Werkspoor, and one Burmeister & Wain, Diesel-driven motorships. Discussing the question of motorships with a representative of the Syren and Shipping, of London, England, Mr. Thoresen expressed himself as an enthusiast. "We, in Norway, are convinced of the superiority of this type," he said. "The economy in fuel, reliability in engine work, and the saving of time and cost in bunkering are substantial advantages of which the Thoresen Company intend to take advantage."

In addition to the B. & W. motorship building at Copenhagen, and many Werkspoor motorships building in Holland, the first of which was illustrated in our June issue, two of the Wood-Skinner vessels and some of the Hawthorn, Leslie boats under construction for the company in England, are being equipped with Werkspoor Diesel-engines.

Comparing cost of building, Mr. Thoresen said there was not much difference between the Dutch, British and Scandinavian countries, taking cost and speed of delivery into consideration. The orders placed for motorships in Holland had been given in the hope of quicker delivery, but this hope had not been fulfilled.

On the question of freights, Mr. Thoresen was dubious whether pre-war levels would ever obtain again. The enormous amount of tonnage building would have to come into service and must depress open market rates. But expenses of operation have risen to a point that entirely precluded the possibility of liner freights—in which, of course, he is principally interested—receding to any great extent—for some time to come, anyhow.

Questioned as to the future of American shipping, Mr. Thoresen was by no means optimistic. He said the manner in which American shipping in connection with Norway was operated caused astonishment in Norwegian shipping circles. So sparsely populated a country as Norway had no need of frequent fast cargo-liner services to all ports. Such services could only be of a "mushroom" nature. Mr. Thoresen is president of the Norwegian Liners' Association and a director of the Norwegian-American Line.

Our Readers' Opinions

(The publication of letters does not necessarily imply Editorial endorsement of opinions expressed)

FACTS FROM SWEDEN

To the Editor of "Motorship."

Sir:

Oil-fuel boiler installations are not much in favor with Swedish shipowners, and I think they are right, as it is a terrible waste of fuel.

The 9,400 tons motorship "Tisnaren' has arrived back here from Java, and, as reported in "Motorship," the copra in the after cargo hold caught fire through self-ignition. The ship was sunk in shallow water to extinguish the fire. However, the engine-room was kept dry by her Diesel-electric pumps, so there was no damage to the motor machinery whatever.

She was raised and docked in a short time, and proceeded to Sweden with a full load of cargo, averaging over 12 knots on the long voyage. Upon arrival there was no work to do on her Diesel engines.

Yours very truly,
ERNST A. HEDEN,
Götaverken.

Göteborg, Sweden.
Apr. 16, 1920.

THE EX-CHAIRMAN OF THE U. S. SHIPPING BOARD RAISES A VERY IMPORTANT ISSUE

To the Editor of "Motorship."

Sir:—

I am very glad indeed that "Motorship" is pressing the project for Diesel motorship construction. It is a singular commentary on our Governmental blindness in maritime matters that the United States, a high wage and oil-producing nation exporting a great volume of bulky products, has not today a single fleet of Diesel vessels and that up to a very recent date, if at all, no practical encouragement had been given by the Government in our shipping program to the building of large commercial Diesel units, of 1,500 indicated horsepower and up.

You ask why this is? There are a number of reasons, but the chief one has been the entire absence from our Government administrators, in the past, of men in practical touch with shipping problems. My own experience probably affords some explanation of the reluctance of any man to risk his reputation to the cross currents of private interest and political maneuvering, inevitable in the capital of a great but loosely co-ordinated government. For instance, my most important personal contribution to the creation of a war fleet was the project presented to Congress on May 5, 1917, for the stopping of all peace-time steel construction, such as high buildings and bridges, and a drastic concentration of all our steel producing power on ships and munitions. I was the first administrator in Washington to advocate this. I urged and facilitated in every way I could the making of contracts for steel vessels.

On April 5, the day after war was declared, I announced that our wooden ship project was merely an emergency auxiliary to steel ship construction which I called the "major program." I then called attention to the inferior character of wooden vessels as compared to steel. This was ten days before we employed General Goethals, and yet today fifty per cent of the persons, who think of it at all, regard me as the advocate of a small wooden ship overseas war tonnage to the exclusion of steel construction.

It is doubtful if five per cent of the shipping world is aware of our plans regarding a Diesel-driven, steel motor fleet. It is not at all surprising that you ask why the Government has not forced the construction of Diesel motor cargo ships with some small part of the billions of dollars it has expended for steam vessels, many of which cannot be delivered till at least two years and a half after our declaration of war.

It is true, as you have pointed out, that over three years before the war, the Diesel motor cargo ship of over nine thousand tons dead weight had shown its great superiority over steam vessels, even with oil as fuel. It is true, that every master mind in the commercial shipping world was shaping the prospective future reorganization of his fleets on the basis of the demonstrated economics in space, deadweights, fuel and, above all, crew's wages of the vessels of the type of the "Siam" and the Norwegian "George Washington." It is true that in vessel after vessel there had been successful use of Diesel motor units of 500 horsepower and above, producing in twin-screw installations, on 9,500 ton vessels, voyage after voyage of eleven to twelve knots sea-speed with a daily fuel consumption of around twelve tons of oil.

When the Shipping Board was organized in January, 1917, it had been clearly demonstrated that every distinguishing feature of the Diesel motorboat fitted into the peculiar national need and natural resources of the United States. Our ship wages are the highest of all the competing maritime nations; the Diesel reduces to a minimum that most dangerous cost element in our struggle with rival nations having cheaper labor. Our lack of bunkering facilities in foreign waters rendered our steamers under peculiar obligations to other nations.

These vessels for many years before we commenced our shipping program, had made their 11 knots an hour in round-the-world voyages with a sailing radius capacity in their double bottom tanks of 25,000 miles—that is once around the world past the bunkering stations of every maritime nation. Such experiences had been repeated in more than twenty other vessels of over 6,500 deadweight tons before we formulated our policy regarding them. Our bulky farm products need the ship's space above our rails and plates and bars; the Diesel ship gives a greatly increased percentage of space with its absence of boilers and bunkers. The Diesel ship burns crude oil; we and our neighbor, Mexico, have at home on this continent the largest fields of oil in the world. So, we need not wonder why it is asked why nothing has been done towards assisting American manufacture to develop Diesel engine motors of the larger sizes.

What does surprise me is the fact that the country does not seem to realize that it was the declared policy of the Shipping Board during my chairmanship, to make the development of the Diesel a part of our war building program as well as our contribution to our permanent after-the-war maritime fleets.

It happened that my experience as attorney for the Pacific Coast agents of the Olsen fleet of Diesel ships made me familiar with the experience of the "Bayard," "Brazil" and "George Washington," and I brought to the Board a keen realization of the country's need for vessels of this type. In the year 1916, I personally chartered the "George Washington" to the Navy Department for the carriage of coal from an Atlantic port to San Francisco.

In June, 1917, the Shipping Board persuaded a group of interests, among them the Wm. Cramp Shipbuilding Company, to organize for the building of a fleet of twenty-four Diesel-driven steel motorships. The machinery for building the engines and the ways for the 24 hulls were fully arranged for. The plans of the vessels and engines secured the approval of Mr. Ferris, then the Fleet Corporation consulting engineer and designer, and the question was under discussion whether we should award a contract along lines suggested by these gentlemen, or commandeer their proposed plant and patents and make the venture a national one.

The first vessel was to be delivered in thirteen months and the balance one a month. The contract called for hulls of the Santa type which had then been developed by our own Mr. Rosseter. The summary of the specifications was as follows:

1. Deadweight capacity ....9,588 tons
2. Length over all ....420 ft., 6in.
3. Length between perpendiculars (Lloyd's) ....404 ft., 6 in.
4. Beam, moulded ....36 ft., 9½ in.
5. Depth, moulded ....36 ft., 9½ in.
6. Draft, loaded ....28 ft., 4½ in.
7. Deadweight capacity at 28 ft, 4½ in., 9,588 tons
8. Cubic capacity, grain, about.....476,000 cu. ft.
9. Gross tonnage, approximately.......6,500 tons
10. Net tonnage, approximately.........4,500 tons
11. Fresh water tank capacity (drinking).34 tons
12. Oil capacity ....34 tons
13. Speed on trial ....12 knots
14. Indicated horsepower 3,000
15. Radius of action ....24,000 miles
16. The main propelling machinery will consist of

On July 24, 1917, the day set for the final discussion of this question (in which we were in substantial accord) both General Goethals and I resigned.

It is my understanding that at a very recent date the Government had not as yet placed any contracts in America for the larger Diesel engines. The organizing work of the Cramps and their associates in the Spring of 1917 came to nothing. Why this is, I do not know.

It has been suggested that there would have been difficulty in obtaining a personnel to handle the engines of these twenty-four ships during the period of their construction. This position is hardly tenable in view of the numbers of green men who, during that time, have been taught to handle the vastly more complex and powerful engines of our naval vessels. *The proposal provided for instructing engineers during the construction of the engines.*

Whatever the cause or causes may have been, it certainly cannot be said that the first Shipping Board either failed in its vision of the national need or in its initiation, at least, of an enterprise which would have embodied in an actual fleet the realization of that vision. I am thoroughly convinced that had the project gone forward we would have gained at least eighteen months in our race for national supremacy on the seas.

In your strong advocacy of the motorship, you are rendering a public service. I trust every other American maritime publication joins with you.

Yours very truly,
WILLIAM DENMAN,
1020 Merchants Exchange Building,
San Francisco, Cal.

May 17, 1920.

[Elsewhere in this issue another correspondent suggests that a powerful "Black Hand" is working against Federal adoption of the merchant marine Diesel engine.—Editor.]

TRIALS OF DUTCH MOTOR SCHOONER

"Tadla," a new 370 ton d.w. motor schooner built by J. Koster & Zu, Werf Gideon, Groningen, Holland, recently ran trials. She is owned by the N. V. Sleepboot Zealandia, and is propelled by a 90 h.p. Kromhout surface ignition type oil engine.

Holeby Diesel Engine Installations

Built During Year Ending Dec. 31st, 1919, for Danish Merchant Ships

AUXILIARY-SCHOONERS

M/s	Deadweight Capacity Tons	Builders of Hull	Engine	B.H.P.	Numbers of Cyl.	Engine Speed (Revs. pr. Min.)	
"Kongedybet"	600	Aktieselskabet Svendborg Shipyard, Svendborg, Denmark	HOLEBY Diesel Engine, 4-cycle, with Reverse-Gear	160	4	240	Steel Hull
"Margot"	600	do.	do.	160	4	240	"
"Poul"	600	do.	do.	160	4	240	"
"Mogens Koch"	600	do.	do.	160	4	240	"
"Agathe"	550	Poulsens Shipyard, Rúakøbing, Denmark	do.	160	4	240	Wooden Hull
"Anne Kirstine"	550	do.	do.	160	4	240	"

FULL-POWERED MOTORSHIP

M/s	Deadweight Capacity Tons	Builders of Hull	Engine	B.H.P.	Numbers of Cyl.	Engine Speed (Revs. pr. Min.)	
"Svendborgsund"	800	Joergensen's Shipyard, Thuroe, Denmark	HOLEBY Diesel Engine, 4-cycle—Directly Reversible	300	6	210	Wooden Hull